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## EDITORIAL

## QUININE

THE present year marks the tercentenary of the introduction of the use of quinine from the New World to the Old.

The medicinal properties of the bark of the Cinchona plant were known to the inhabitants of South America long before they were learnt from them by the Jesuit Missionaries. The bark of the plants became known to Europeans as Jesuits' bark because it was through the Jesuit priests that it was obtained by those adventurous spirits who visited the fields of Spanish Conquest in South America. It was through such channels that Jesuits' or Peruvian bark first found its way to Europe in 1630. So common was malaria in Europe at this time that the regular method of purchase of the prophylactic was by putting gold in one scale pan and its weight of bark in the other. The Cinchona shrub was introduced to the East at a much later date after its therapeutic value had become established in Europe. It was Sir Clements Markham who in 1861 first sent seeds of the Cinchona plant to Ceylon and in the following year a consignment of plants was sent to the East through Kew and were distributed to Hakgala and India.

Ten years after its introduction the plant had established itself as a crop of considerable importance in the upland regions of Ceylon. From this time forward Cinchona in Ceylon presented that succession of phases that has marked others of our crops—demand at high prices, disease, neglect and disappearance. At this stage the Dutch came forward with the intensive application of scientific methods and State control. They trebled the yield of quinine from the bark, largely by the application of methods of multiplication by grafting from high-yielding shrubs, until to-day the world's chief supplies of quinine come from Java. The once famous Cinchona forests of South America have now lost their importance. India however under State control produces a considerable quantity of Cinchona bark for her own consumption. From this quinine and other products are produced to the value of some five and a half lakhs annually. These products are made readily available to the people as a malaria specific, being cheaply distributed through the post office and purchasable at a low price wherever one can obtain a postage stamp. Science, however, today has advanced the production of quinine to a stage when synthetic products are upon the markets and the article from natural sources may before long share the fate of indigo.

For the present however if the State, as in Bengal, can provide from natural sources at a cheap rate a supply of quinine for its malaria-stricken population it is its duty to do so. In this issue will be found on another page the report of this industry in Bengal.

# ALTERNATIVE GREEN MANURE PLANTS

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NEW leguminous plants are frequently tried on the Experiment Station, Peradeniya, and though their growth and behaviour may be satisfactory they may appear to have no special claim to be considered superior to the better known plants in general use for the purposes for which the new plants appear suitable. The word "new" in this connection must be taken to include plants not widely used as green manure or cover plants in Ceylon.

Every now and then, however, an estate superintendent reports that he sets a high value on a plant which possibly has not appeared at Peradeniya to have any special merit and has not attracted any widespread interest. It may be in some cases that the plant in question is especially suitable for the particular conditions found on that estate, or it may be that the superintendent has taken a personal fancy to the plant ! In any case it is always a good thing to have a second string to one's bow and to know that there are serviceable alternatives to the plants commonly used. The following plants appear to have some promise, and seed is available in limited quantities from the Experiment Station, Peradeniya, or from the Central Seed Store, Peradeniya. It may be mentioned that the uses of all these plants are fully discussed in Section II of the Manual of Green Manuring which is awaiting publication. Multiplication of seed of most of these plants would be an easy matter should a demand arise.

## TREES

*Cassia didymobotrya.*—This small leguminous tree has given satisfaction at least to two estates in Dimbula. It is easily propagated from seed, and furnishes a good weight of loppings which are rich in mineral constituents. At Peradeniya growth is more rapid and apt to be straggly. In any case young plants should be staked.

*Derris microphylla.*—This is now a very popular shade tree for tea and coffee in Java. It is suitable only for mid and low-country. It is reported to grow rapidly, stand wind well, and to be immune to a considerable extent from pests and diseases. The tree is reported to be giving satisfaction on Sirikandura Estate, Matugama. Seed was recently imported by the Central Seed Store, Peradeniya.

*Dalbergia assamica.*—This tree which gives a light shade and considerably resembles *Albizzia moluccana* has made very rapid and healthy growth at Peradeniya.

## BUSH PLANTS

*Crotalaria brownei.*—It is not claimed that this plant is superior to *Crotalaria anagyroides* or *C. usaramoensis*, but recent trials show vigorous growth and the possibility of a useful supply of green material in the young stages. A limited quantity of seed is available.

*Desmodium cephalotes.*—This indigenous plant has a spreading habit and may prove useful for lopping. The first plants grown produced an abundance of seed and some of this will be used for multiplication in the next rains.

*Desmodium gyroides.*—This erect plant has been grown for some years on the station but has not yet attracted much attention. It provides, however, a good weight of green material and stands lopping at least better than the *Crotalarias*.

*Indigofera suffruticosa.*—This plant very much resembles *Indigofera arrecta* which is fairly well known. It can be easily distinguished from that plant by its seed pods which are curved instead of straight. Its habit is perhaps slightly more spreading than *I. arrecta*.

*Tephrosia tinctoria.*—This plant is very easily grown at Peradeniya and gives a satisfactory light even cover. The weight of green material afforded is less than that available from *T. candida* or *T. vogelii*.

*Tephrosia vogelii.*—This plant has achieved some popularity in a few districts but has possibly not yet received as much attention as it deserves. It has some resemblance to *T. candida* (Boga medelloa) but can be very easily distinguished by its seed pods which are much larger, very hairy, and have a texture resembling that of a veloor hat. At Peradeniya it is indicated that the production of green material is more prolific in the young stages but the life of the plant is shorter than that of *T. candida*. The great point in its favour is that the seed pods are much less liable to insect attack than those of *T. candida*.

## CREEPERS

*Dunbaria heynei.*—This indigenous creeper forms a very satisfactory cover where it is found to be growing spontaneously. It has been found most satisfactory in young rubber on the Kegalle Experiment Station.

*Pueraria phaseoloides.*—This creeper is perhaps better known under the name of *Pueraria javanica*. It forms a heavy cover at Peradeniya and seeds prolifically.

# THE CINCHONA INDUSTRY IN BENGAL*

1. *General.*—Although the interests of public health, in so far as these are dependent on quinine supplies and their distribution, cannot be shown to have been advanced far during the year, and although the correlation of suppply and demand in this market presents its old-time difficulties, the year has been a favourable one indeed for the Cinchona Department. A season exceptionally well suited to the growth of established Cinchona with a bumper bark harvest and steady progress in the factory is reflected in accounts which are at once a vindication of past policy and a pointer to what may be expected from its continuance in the fields of Cinchona and Quinine production.

But we have been working under favoured conditions, and to the year's success sound plantation management and fortunate climatic conditions have not alone contributed.

Quinine holds a position unique in a world of surplus commodities. For a series of years the price of the drug has remained unaffected by all those factors which have been operating in other fields. In 1926 Rs. 18 was fixed by the Kina Bureau as the price at which its product should be released, and the power of those who guide supply in this commodity may be gauged from the fact that fluctuations in price have reflected little more than differences in exchange values during the intervening period. When it is realised that overproduction in quinine is as marked as it is where some of the world's staple commodities are concerned the question may well be asked how quinine escapes effects so evident elsewhere. The answer is that while it is being produced in quantity in excess of the world's demand stocks are still well below real world requirements as measured by health standards, and both price and production remain under a control which, called for and welcomed by the industry itself is now loyally supported as in its best interest and as the only means of maintaining its steady economic development.

We are here, therefore, dealing with production under control. In cases of overproduction the absence of control does not require in these times to have its effects demonstrated. We see them in the rates for tea, rubber and tin, to mention three important eastern products only, falling to a point that makes the less well-managed concerns go to the wall. Prices, indeed, in some cases have reached a point beyond which the industries continue only in the hope of better times and because of the disorganization and difficulty of reorganization that would follow a disruption of labour forces.

That it is otherwise in the Cinchona and Quinine industries has been to the benefit of all concerned in these different trade times, and if the Cinchona Department can with others regret the restricted use of its product it can yet rejoice in the guidance the industry has and congratulate itself in escaping the depression so evident elsewhere. For here both price and production are steady, the former because, in spite of much that is said to the contrary, it is not greatly in excess of costs, the latter because the product remains unaffected by long storage and the industry can afford to await a time when effective yearly demand will more nearly balance, if not exceed, yearly harvests.

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* From the Sixty-Eighth Annual Report of the Government Cinchona Plantations and Factory in Bengal for the year 1929-30.

The reasons for such strength in this industry are interesting. Political causes have determined that in the areas of South America where the plants are native, labour cannot be organised to develop and maintain a Cinchona industry thriving as it would thrive nowhere else, and outside its native limits the plant takes unkindly to generally prevailing climatic and soil conditions. They are chance coincidences that the one area of the world outside America most suitable for this cultivation should be limited to two large islands in the Malayan Archipelago, that both these islands should be governed by a single Power and that this Power should be that which, above all other European, has shown powers of co-operation in production and marketing and an ability equal to the best in matters of the scientific organization and development of land industries. With these considerations for backing the result does not surprise and we find an industry standing up against world economic disruption as no other industry is standing.

The steadiness of price might indicate monopolistic influence; indeed it is to this that it is usually ascribed, and yet the only monopoly the Dutch have has been determined for them by the fact that quinine, the Cinchona alkaloid easiest of production in their possessions, is also the one most favoured as a febrifuge by the medical world. Were it otherwise the history of the campaign against malaria might read very different to what it does. The favour that quinine enjoys above others may rest on well found clinical experience but it is not the only alkaloid nor is it the only useful one, and, strict adherence to it has directed the effort against malaria in a way that is, perhaps, too little understood. Quinine is, and, till South America is more settled politically, must always remain a Dutch Eastern product. No other known part of the world can compete with Java. Its climatic and soil conditions give it advantages unknown elsewhere so far as the particular alkaloid quinine is concerned. But the preference shown for quinine has determined more than has anything else the limitation of areas suitable for development as febrifuge yielding centres, and it more than any other is the real cause of such monoply as the Dutch now exercise in this field of production. It is a monoply that nature forces on Java by reason of medical preference. The rigid adherence to quinine connotes the maintenance of a monopoly in the true sense of this word. It means the continued development of a Cinchona industry directed towards quinine when an industry having as its aim a balanced production in greater mass of all the useful alkaloids might have more far-reaching effects in the world control of malaria. We cannot get away from the fact that quinine is the rich man's remedy while malaria is the poor man's heritage, but let medicine once admit and practise the value of the other alkaloids and many Indian areas might then be turning out febrifuges at costs more suited to the poor. For with a change in medical opinion and practice we could make use of kinds of Cinchona that do not demand Java soil and climatic conditions for their best development, and the truth will have been recognised that the elimination of malaria means first its control in that section of the population which has scarcely heard of quinine and which cannot afford to buy it even at cost price. If the year's accounts show that the problems of production are being tackled with success this is the better reason why the present difficult problems of consumption should not be brushed aside. They are great but on their solution depends further advance, and so long as they are not solved must the success attained in production miss its mark.

2. *Extensions, Acreages and Crops.* (a) *Mungpoo*—Rainfall for the year was considerably above the average and varied between 135 inches on Labdah to 187 on Sittong. Mungpoo division with 142·5 inches compares with previous recorded yields. Rain fell in each month of the year and this

taken with normal temperatures accounts for the flourishing condition of Cinchona on this plantation. The writer has never seen the lower blocks so free of insect disease and taking the blocks all over, has never seen Cinchona on this plantation look so well as it did towards the end of the year. Favourable appearances are also accompanied by better laboratory records for the barks, and it is interesting to note that analyses of Ledger barks now average over 5 per cent.

To obtain reliable samples for analytical purposes small quantities per maund are saved from each barking operation, thus obviating the objection to averages obtained from a limited number of selected trees. Hybrid blocks are also averaging well with Hybrid II on the different divisions showing percentages of 5·06, 4·55, 4·58, and 4·74. The improvement in Hybrid bark may be of first importance not only to Cinchona in the Darjeeling district but to the cultivation of this tree in many areas not yet tried. For the Hybrid tree is more robust than either of its parents and thrives at elevations and in soil conditions not suited to them. It is particularly gratifying to find last year's planting at low elevations looking so well, for at one time everything in these blocks pointed to failure and had there been a heavy eventual mortality it would have occasioned no surprise. As things are, the mortality is negligible and, given any luck in the current yearly conditions, a real good area of well-established Cinchona at an elevation lower than where one looks for the best should result.

But nowhere is the success of the year more apparent than in coppiced blocks. The operation of coppicing with a finely balanced tree like Cinchona is always attended with some risk and it is, therefore, gratifying in a way that success in other operations is not to find a coppiced area breaking regularly and freely and to see it springing up in a fresh crop of Cinchona without any of the risks attending nursery work and inclement planting weather.

An extension of 130 acres for which 205,870 young plants were reared enabled the plantation to balance the acreage cut out and retain a fully stocked area of 1,049 acres. The new blocks were made up of 59 acres Ledger on Mungpoo and 22 acres Ledger on Labdah, 17 acres Succirubra on Mungpoo and 32 acres Hybrid II on Labdah. Excellent weather conditions prevailed at the time of planting and the land selected was in good fettle after a twenty years' rest in young forest. These blocks are confidently expected to do well.

Harvests were obtained by cutting out 116 acres Ledger, 4·2 acres Succirubra and 9·8 acres Hybrid II. The yields were 415,916 lb. Ledger, 16,420 lb. Succirubra and 35,441 lb. Hybrid barks, total 467,777 lb. the largest harvest ever got from this plantation. The harvest came from the coppicing of three eigth-year-old blocks, from casualties throughout the plantation and, to a lesser degree, from the pruning of young overcrowded Cinchona. The average ages of the Ledger, Succirubra and Hybrid barks were 9·2, 10·9 and 8·7 years, the average annual increments calculated on the harvests 387, 358, and 412 lb. The average age of all barks cut is 9·2 years and the average annual increment 390 lb.

(b) *Munsong*—Rainfall for the year was 109·56 inches which is 12·28 inches above normal. The total represents a plentiful supply for Cinchona and generally the distribution was good. There were, however, excessive falls in September and October that did more immediate damage by washing out plants and destroying roads than ultimate good in keeping the soil moist for the first period of the oncoming dry weather. Nurseries suffered considerably from cold which accompanied the rain in January and February, but apart from this the year was exceptional in that no material damage resulted from drought.

Variations in temperature from day to day were more marked than usual. The lowest recorded at 4,250 feet was 40° and this occurred several times from December to February. Damage by hail, the most destructive element next to prolonged drought and usually prevalent in times of low temperature has, however, not been reported.

In spite of the prevalent nursery disease the extensions of last year have done quite well as is evidenced by a vacancy percentage of 10·3 in Kashyem Ledger 29. This, however, is the block giving best results and something between its percentage and a failure of 33 per cent. on Munsong Ledger for the same year can be taken as representative of the year's success. Experiments with shade trees and green manures are helping to prove where further planting can be tried on land that has already borne one Cinchona crop. The majority of the blocks were given a deep forking during the year with the help of outside contract labour. A stage has now been reached in this plantation when further extensions must go on land that has already borne its crop, but everywhere the presence of scattered Cinchona will prevent homogeneous planting. These conditions are the direct result of a policy of bark importation with its corollary of late and gradual local harvesting and of the retention of healthy plants wherever possible and regeneration by wholesale coppicing. For some considerable time no area has been completely uprooted, and, as no new good land remains, extensions henceforth must take the form of repeats in areas still partially stocked. The policy of coppicing any plant that had the slightest chance of growing has been called in question during the year by large numbers of stocks failing to break, but admitting that this makes the final removal of bark more difficult, the practice must continue so long as the nursery disease interferes with our normal planting programme. In its presence nothing will justify the complete removal of Cinchona that, coppiced, might again yield its bark harvest.

The continued prevalence of the nursery epidemic overshadows all other plantation considerations for the moment. Further experiments in the disinfection of nursery soils and sites have not pointed to any easy specific for the disease, but it was premature to say that a plant once attacked was doomed in the struggle against it. This is not borne out by subsequent experience and the attempts made by mildly attacked plants to throw off the disease once in the open is perhaps the most promising indication of how the trouble may be countered. Very early planting to permanent situations in the field before the condition becomes epidemic in the nursery, may prove at once the prevention and cure of the disease and the solution to a problem that is of immense importance to Cinchona in the whole district.

The effect of various degrees of nursery shade is being tested and, with the idea that the times of sowing may affect the virulence of the attack, experiments in this direction are being carried out.

The outstanding facts of the year are that the disease persists and that a good measure of success has been attained in spite of it. Its presence on Mungpoo has also been established but here it is not epidemic and does not show up till after the plants have passed the nursery stage.

Extensions, by which is meant the area of young plants put out irrespective of whether they grow on new or old Cinchona land, comprised 56·5 acres Ledger only, 40·5 acres on Kashyem and 16 on Munsong division. This is a meagre extension but the factors conditioning it are well known to Government.

Harvests were obtained by cutting out 141·4 acres Ledger, small areas of just over 2, 2, and 3 acres of Officinalis, Succirubra and Hybrid III and 17·2 acres of Hybrid II. The yields were 567,539 lb. Ledger, 5,477 lb.

Officinalis, 12,845 lb. Succirubra, 8,778 lb. Hybrid III and 67,986 lb. Hybrid II, making a total of 662,625 lb. for the year. The average ages of the Ledger, Officinalis, Succirubra and two Hybrid barks in above order were 10·9, 16·3, 13·2, 9·6, and 12·6 years and their average annual bark increments 368, 146, 317, 292, and 313 lb. respectively. The average age of all cut barks was 11·16 years and the average annual bark increment calculated on the harvests 355 lb.

Labour supplies, due no doubt to the depressed state of the tea industry, are more satisfactory on Munsong than they have been for years. There is a balance of 148 to the credit side in the force which seems more settled since an increased quantity of piece work has been given out.

3. *Factory Work.*—Besides, 28,127 lb. Java and 21,080 lb. Burma bark for the Government of India, 485,298 lb. Mungpoo (450,536 lb. Ledger, 12,818 Succirubra, 21,944 Hybrid) and 575,358 lb. Munsong barks (499,922 lb. Ledger, 7,188 lb. Officinals, 9,691 lb. Succirubra, and 58,557 lb. Hybrid) were worked up to produce 29,050 lb. quinine sulphate powder (crude), 4,919 lb. and 79,297 boxes tablets, containing combined, approximately 13,000 lb. quinine sulphate, 726 lb. other quinine salts, 15,681 lb. Cinchona febrifuge powder and 4,397 lb. Cinchona febrifuge powder converted to tablets.

The Java and Burma barks produced 2,090 lb. quinine sulphate and 932 lb. Cinchona febrifuge powder.

The Mungpoo bark had an average quinine percentage of 4·22 and the Munsong 4·42.

Only 13,940 lb. of the sulphate were fully purified and packed, the remainder being left half purified and stored in the large concrete bins. This expedient is rendered necessary by the large and steadily accumulating stocks and by the failure, so far, of all attempts to finance their use in the malaria campaign. No salts of other Cinchona alkaloids were manufactured during the year but some 100 samples of local bark and 79 samples of Burma bark were analysed with a view to the selection of seed trees. The large areas growing out in Burma added to drains on the seed harvest following nursery disease make the question of supply an important one.

The work on tablets which till a few years ago was done by juvenile jail labour, has been very successfully transferred to machinery at the factory and is running both smoothly and efficiently and at greatly reduced cost. A tendency to order quinine in tablet form is now noticeable and is likely to become more pronounced. Steps have been taken to substitute glass tubes for the cardboard cases now used and machining has arrived from home for the manufacture of the necessary caps. The appearance of the make-up will be enhanced and in this respect the Government product will be brought into line with the more attractive trade brands of quinine.

4. *Cost and Value of Plantation Bark.*—The figures 3·6 annas for Mungpoo and 2·7 annas for Munsong bark are retained. Mungpoo total harvest of 467,777 lb. and Munsong 662,625 lb. therefore, cost Rs. 105,249 and Rs. 111,818, total Rs. 217,067. The unit rate for bark taken at 1 anna gives the Mungpoo bark harvest with an average quinine percentage of 4·9 for Ledger, 3·08 for Succirubra, and 4·73 for Hybrid a value of Rs. 141,011 or Rs. 35,762 more than its cost. The same unit rate for Munsong barks with percentages of 4·62 for Ledger, 3·58 for Officinalis, 2·55 for Succirubra and 4·07 for Hybrid gives the harvest from this plantation a value of Rs. 186,674 or Rs. 74,856 more than its cost.

The pond unit rate is retained at one anna for valuation purposes, a figure low enough to serve for both standing and harvested bark.

5. *Cost and Value of Quinine Produced.*—(a) Cost in the bark. Not counting a questionable amount of quinine passing through into the febrifuge, 29,050 lb. crude quinine sulphate, about 13,000 lb. sulphate in tablets and about 726 lb. in other salts, a total of 42,776 lb. were contained in 1,062,806 lb. mixed Munsong and Mungpoo barks, costing at 3·6 and 2·7 annas a total of Rs. 206,768. The cost per lb. of quinine in the bark was, therefore, Rs. 4·83.

(b) Cost of extraction, packing and delivery to railway.—No advance on the figure of Rs. 2·721 for cost of extraction has been made. It has been used as a basis for charges to India and it is not proposed to change it pending the elaboration of commercial accounts.

(c) Total cost per lb. and value.—This is made up of the cost in the bark Rs. 4·83 and cost of extraction Rs. 2·721, a total of Rs. 7·55.

The wholesale rate being Rs. 18 per lb. the 42,776 lb. quinine extracted in all forms as above defined are worth Rs. 769,968 but cost only Rs. 322,958.

6. *Sales and Selling Rates.*—No change has taken place in the selling rates since last report was written, there having been only fractional changes in the open market quotations.

Sales reveal in comparison with last year the following main differences —quinine salts exclusive of tablets 8,431 lb. sold against 11,502 lb. last year; Cinchona febrifuge 16,087 lb. against 17,633 lb.; quinine sulphate tablets by weight 4,147 lb. against 3,470 lb.; by treatments 89,718 boxes against 79,612 boxes. The total sales of all kinds cash and credit and including Rs. 5,190 received direct by the Department for miscellaneous products amounted to Rs. 617,513. Of this Rs. 285,481 were by sales of quinine tablets.

7. *Expenditure and Receipts.*—The total expenditure of the department (including pensionary charges) was Rs. 416,096. Total receipts exclusive of Rs. 5,717 from land rent, grazing fees, etc., paid to the treasury not to the credit of the Cinchona Department, but inclusive of Rs. 5,190 received direct from miscellaneous products, etc., were Rs. 617,513. Of this amount a sum of Rs. 29,648 is deducted for credit to the Jails Department for distribution of products, leaving a balance of Rs. 587,865-8 for entry in the profit and loss valuation account.

Outstandings at the end of the year amounted to Rs. 18,612-8 being Rs. 11,229-8 unrealised sales, Rs. 5,687 for extraction of 2,090 lb. sulphate at Rs. 2·721 per lb. and Rs. 1,696 for extraction of 932 lb. febrifuge at Re. 1·82 per lb. on behalf of the Government of India.

# THE WORLD'S RUBBER SUPPLIES*

IN the course of a paper on "The World's Rubber Supplies," delivered at Birmingham before the Midland Section of the Institution of the Rubber Industry by Dr. George Rae, D.Sc. (Messrs. Harrisons and Crosfield, Limited), on Tuesday, 13th January, 1931, the speaker pointed out that rubber is to-day mainly obtained from plantations, wild rubber, which 30 years ago was the only source, representing only about 3 per cent. of the total world supply. Under the stimulus of the high prices obtaining during the early years of the century rubber planting was carried out at a rapid rate, especially after 1905, both by Europeans and Asiatics. The Asiatic proportion rose from about 20 per cent. of the total in 1910 to 35 per cent. in 1920 and to over 50 per cent. in 1930.

The total area under plantation rubber at the end of 1929, continued Dr. Rae, was between 6,600,000 acres and 7,200,000 acres, of which the area under native rubber in the Dutch East Indies variously estimated at between 1,100,000 acres and 1,700,000 acres. The estimates of the area under Dutch native rubber are based on the exports of this rubber and on the opinions about its average yield per acre and about the proportion of its immature to its mature rubber. The remaining 5,500,000 acres consists of approximately 3,360,000 acres in estates owned by Europeans and Americans; 510,000 acres in Asiatic-owned estates over 100 acres and 1,630,000 acres in native holdings under 100 acres. About 80 per cent. of all the estate rubber trees are tappable. 90 per cent. of the native rubber in Malaya and Ceylon is tappable and probably less than 50 per cent. of the native rubber elsewhere is tappable. Owing to the drastic system of tapping pursued by the natives, a portion of their untapped areas must be regarded in the same light as bark reserves of estate rubber.

The total exports of rubber from producing countries were 94,000 tons in 1910, 167,000 tons in 1915, 353,000 tons in 1920, 518,000 tons in 1925, 861,000 tons in 1929, and will be about 820,000 tons in 1930. Under normal conditions of production, exports give a good approximation to output and the stock figures now published will usually indicate any significant divergence between output and export.

The nett exports from the various producing countries during the years 1920, 1925, 1929 and 1930 are given in the following table (the 1930 figures are subject to adjustment when complete data are available):

| | 1920. Tons. | 1925. Tons. | 1929. Tons. | 1930. Tons. |
|---|---|---|---|---|
| Malaya | 181,000 | 210,000 | 455,000 | 443,000 |
| Ceylon | 39,000 | 46,000 | 80,000 | 77,000 |
| Netherlands E. Indies | 80,000 | 189,000 | 256,000 | 241,000 |
| India | 6,000 | 10,000 | 12,000 | 11,000 |
| British N. Borneo | 4,000 | 5,000 | 7,000 | 7,000 |
| Sarawak | 2,000 | 9,000 | 11,000 | 10,000 |
| French Indo-China | 3,000 | 6,000 | 9,000 | 7,500 |
| Siam, etc. | 1,000 | 4,000 | 5,000 | 4,500 |
| Wild | 37,000 | 39,000 | 26,000 | 19,000 |
| Total | 353,000 | 518,000 | 861,000 | 820,000 |

* By Dr. Geo Rae, D.Sc. in *The India Rubber Journal* Vol. LXXXI. No. 3, 1931.

The actual *output* of rubber for the year 1929 distributed according to the nationality of producers was approximately as follows:

| | | Tons. | | Per cent. |
|---|---|---|---|---|
| British: U.K. | ... | 236,000 | ... | 27·9 |
| British: Local | ... | 69,000 | ... | 8·1 |
| Dutch | ... | 57,000 | ... | 6·7 |
| Other European | ... | 30,000 | ... | 3·5 |
| American | ... | 22,000 | ... | 2·6 |
| Asiatic Estate | ... | 64,000 | ... | 7·6 |
| Malayan Native | ... | 199,000 | ... | 23·4 |
| N.E.I. Native | ... | 108,000 | ... | 12·8 |
| Other Native | ... | 36,000 | ... | 4·3 |
| Wild | ... | 26,000 | ... | 3·1 |
| | Total | 847,000 | | 100·0 |

During the last few years, resting, a better knowledge of the effects of various tapping systems, increased cultivation and conservation of surface soil have increased the yield and probably prolonged the productive life of the estate rubber tree. By far the most important development, however, has been the planting of high-yielding material by means of bud-grafting; the area under budded rubber is unknown, but brobably does not exceed 5 per cent. of the total planted area.

Owing to the low price of rubber many estates are now harvesting a restricted crop; more will restrict during 1931; but a considerable number may find it necessary to harvest a full crop. Dutch native output had declined largely owing to the disappearance of markets in the relatively inaccessible districts and to lack of hired labour at the current prices, but will again increase when the price rises. The output of Malayan native rubber during 1930, for which so far there has always been a market, has been maintained at about the 1929 level, although during the last three months it has shown a tendency to fall off; any falling off will be due to depletion of bark reserves.

The absorption of rubber by manufactures (*i.e.*, the quantities or rubber they turn into rubber goods) was 85,000 tons in 1910, 150,000 tons in 1915, 310,000 tons in 1920, 560,000 tons in 1925, 790,000 tons (adjusted figure) in 1929, and will be approximately 705,000 tons in 1930.

The absorption by manufacturers in the United States is given monthly by the Rubber Manufacturers' Association of America; similar data are not available for other countries, but their absorption can be measured approximately by their nett imports, adjusted in the case of the United Kingdom for variation in the stocks in public warehouses in London and Liverpool.

The absorption of the principal manufacturing countries for the years 1920, 1925, 1929, and 1930 (preliminary figures) are as follows:

| | 1920. Tons. | 1925. Tons. | 1929. Tons. | 1930. Tons. |
|---|---|---|---|---|
| United States | 215,000 | 390,000 | 470,000 | 380,000 |
| United Kingdom | 24,000 | 30,000 | 72,000 | 74,000 |
| France | 16,000 | 34,000 | 62,000 | 67,000 |
| Germany | 13,000 | 34,000 | 49,000 | 46,000 |
| Italy | 6,000 | 11,000 | 16,000 | 15,000 |
| Russia | — | 8,000 | 13,000 | 17,000 |
| Belgium | 3,000 | 3,000 | 9,000 | 11,000 |
| Scandinavia | 2,000 | 3,000 | 5,000 | 7,000 |
| Canada | 12,000 | 20,000 | 36,000 | 29,000 |
| Japan | 6,000 | 13,000 | 34,000 | 32,000 |
| Australia | 3,000 | 5,000 | 16,000 | 5,000 |
| Other countries | 10,000 | 9,000 | 23,000 | 12,000 |
| Total | 310,000 | 560,000 | 805,000 | 705,000 |

For the years 1928 and 1929 a further adjustment (estimated roughly at 15,000 tons) is necessary to allow for the obvious variation in the stock of crude rubber in the hands of manufacturers outside the United States.

The absorption of rubber has shown considerable fluctuation about its trend during the last twenty years which have probably been of greater amplitude than those shown by the real consumption of rubber. Stocks of manufactured goods, including the unused tyre mileage on automobiles, must, therefore, have shown considerably annual fluctuations during the last twenty years—a matter of considerable importance when considering stocks of crude rubber.

The data both for supplies and deliveries of crude rubber are reasonably complete and reliable, but the data giving the world stocks are very incomplete. Such data as exist, however, indicate that under normal conditions of production, stocks of crude rubber in producing countries and quantities afloat represent mainly working stocks and are not likely to show much fluctuation beyond that due to seasonal variations in output. The only important stocks in manufacturing countries are those in public warehouses in London and Liverpool and in the United States. The stocks in the hands of manufacturers in the United States have usually been between 60 and 80 per cent. of the total United States stocks. The stocks in London and Liverpool are the main reservoirs of immediately available rubber and have accordingly shown large fluctuations during the last twenty years.

The total world stocks, declared and undeclared, at any time must be considered in relation to the monthly world absorption at that time and the ratio of the former to the latter has varied from $5\frac{1}{2}$ to 11 during the past two years and has shown even greater fluctuation in the past. A total world stock equivalent to about six months' absorption is usually regarded as necessary for the smooth working of the industry.

# INVESTIGATION INTO THE RELATION BETWEEN THE DIAMETER OF THE LATEX TUBES AND THE RUBBER PRODUCTION OF HEVEA BRASILIENSIS*

## INTRODUCTION

*The theory of Ashplant.*—During the last two years H. Ashplant has developed a theory, according to which it would be possible to distinguish with practical certainty high-yielding rubber trees as early as in the nursery stage, so that useful superior planting material could be selected from a very heterogeneous mixture. Ashplant's statements are founded on assumptions, which can be summarized as follows:

1. In a Hevea tree a very striking correlation exists between the yield capacity and the diameter of the latex tubes. This correlation is considerably better than the relation found between the number of latex rings and the yield of rubber.

2. A hevea tree with latex tubes with large diameter in the bark also has large bore tubes in the leafstalk.

3. The size of the diameter of the latex tubes in an individual tree is constant during the whole duration of life, from its earliest youth (6 months old), and hereditary.

From these hypotheses the conclusion is drawn, that a single cut through the leafstalk of a 6-month-old Hevea seedling suffices to decide in all probability whether the tree, when tappable, will be a good or a poor yielder. Unfortunately no proof is adduced for the second and third of the above-mentioned hypotheses, whilst the first is supported by two correlation tables in Ashplant's third publication. In our opinion it is however an omission that not one of the three preliminary papers mentions how the diameter of the latex tubes can be measured with the degree of accuracy given in the correlation tables.

Since this new method of selection would be invaluable for practical purposes, an investigation was started to test this theory after the third publication (December 1928) had not given the detailed description, repeatedly promised, of the method to be used. The more so since on theoretical considerations, mentioned hereafter, a very striking correlation between the diameter of the latex tubes and the production can be expected.

As a consequence of lack of data in his publications it was impossible to adhere to Ashplant's method of working, so that we had to work out our own method of measuring (section 5). It follows that this treatise can only aim at a control of Ashplant's fundamental idea, and unfortunately it is not possible to make a comparison with the figures obtained by him according to an unknown method.

* By Dr. Frey-Wyssling in *Archief voor de Rubber cultuur*, Vol. 14, No. 3, March 1930.

Unfortunately the greater part of the available time was spent in working out a flawless micro-technique for the measuring of the diameter of the latex tubes; consequently the number of trees of which measurements have been recorded is comparatively small; notwithstanding this fact the data are convincing. With a view to the complaints which have been worded of late on the lack of a satisfactory method of measuring, the author considers it desirable to publish his records in order to save investigators from such a loss of time in working out a satisfactory technique.

## 1. THEORETICAL CONSIDERATIONS

1. *The volume of latex tubes.*—When estimating the value of rubber tree according to the quantity of rubber contained in the stem, by considering the volume (1) of the latex tube system, as done by Bendixen it is at once evident that the diameter of the latex tubes plays a far more important part than all other factors which come under consideration.

Assuming that the latex tubes are straight capillaries, the volume of a cylindrical stem (budding) is :—

$$I = n.a.o.r^2 \pi l \quad (1)$$

in which n = number of latex rings
a = number of latex tubes per 1 c.m. of ring
o = circumference of the tree in c.m.
r = radius of the latex tubes in c.m.
l = length of the stem in c.m.

This equation shows that the volume is proportional to be the square of the radius of the latex tubes, whilst all other factors such as the number of rings (n) the circumference (o) etc. only occurs in the first power.

The presumption that the tubes are straight capillaries is however incorrect, since they form a network. Therefore the volume is more accurately determined by measuring the area of 1 sq. cm. of the network by means of a planimeter. The figure thus obtained is a measure for the denseness of network and can be used in the equation (1) instead of a.r. The volume is still proportional, though indirectly, to the square of the radius of the latex tubes.

It follows that a tree, which has latex tubes with a diameter twice as large as those of another tree with an equal number of rings, the same circumference etc., contains four times the quality of latex found in the tree with smaller tubes. This is evidently in favour of the theory of Ashplant.

But actually a yielder should not be classified according to the volume of its system of latex tubes; for what is the value of a considerable quantity of latex if it does not flow out easily and to a satisfactory extent ? Tapping is a dynamic problem and static considerations are not worth much, if we try to obtain the latex from the bark, although naturally the quantity of latex in the whole system of tubes comes under consideration as a reservoir for the issuing latex.

3. *Dinamics of the latex flow.*—Liquid moving in narrow tubes follow the law of Poisseuille. According to this law the volume V which flows from a tube during the period t is :

$$V = \frac{\pi . p . r^4}{8 . l . \eta} . t \quad (2)$$

in which p = internal pressure in the tube
r = radius of the tube
l = length of the tube
$\eta$ = internal friction (viscosity) of the liquid
n = internal friction (viscosity) of the liquid
t = period of flow.

For the latex tubes, (p) is the turgor in the system of tubes and (1) stands as a measure for the area drained; *i.e.*, the area in which the latex flows in the tubes with a given velocity. The observations of De Vries give an idea of the internal friction (viscosity) of the latex; for the equation of Poisseuille however the absolute value is required and not the relative value.

Taking into consideration the number of latex tubes opened by the tapping cut, the following volume of latex V can be expected:

$$V = \frac{n.' a. o.}{3} \; \frac{\pi. p. r^4}{1. \eta} \; . \; t \qquad (3)$$

where (a) and (o) have the same meaning as in equation (1) (only $\frac{1}{3}$ of (o) comes into consideration), whilst (n') no longer stands for the total number of rings, but for opened "productive" rings (see section 10).

It goes without saying that no absolute value can be given to this relation, since the latex tubes are not straight capillaries and the problem of flow is so complicated on account of the numerous anastomoses which interconnect the tubes, that it hardly admits of a mathematical solution; moreover the magnitudes (p) (1) and ($\eta$) change during tapping. However equation (3) gives an insight into the relation between the quantity of latex of flowing out and the various factors. It is to be expected, therefore, that the quantity of latex produced during tapping will be proportional to the number of "productive" rings (n') the number of tubes per cm. of ring, the circumference (o) the turgor (p) the period of flow (t) and in inverse proportion to the length (1) through which the latex is pressed. On the other hand the quantity of latex flowing out will increase with the fourth power of the diameter of the tubes! A tree with tubes twice as wide as those of another tree, comparable in all other respects would produce 16 times as much latex than latter. Only if four different factors in equation (3) were doubled simultaneously (1 and $\eta$ divided by 2) would the yield of the second tree equal that of the first. This being precluded, it follows that the diameter of the latex tubes is theoretically the predominant factor in the latex flow, and therefore the theory of Ashplant seems to be remarkably well founded.

## 2. METHOD OF INVESTIGATION

3. *Suggestions for the investigation.*—Whilst Asplant discusses his theory at great length, the reader is left absolutely in the dark as regards his technique, the data on this being very scanty.

From the discussions of his theory in the literature it is permissible to conclude that he uses a projection apparatus for measuring; it is even mentioned that accurate measuring would be impossible without the use of this apparatus. On the other hand we have the fact, known to every investigator well versed in handling the microscope, that projecting does not increase the accuracy of the microscopic image. If for instance the diameter of a cell can be measured in the microscope with an accuracy of 5%, the projection, enlarging the microscopic image a hundred-fold, does not permit measuring with any greater accuracy, since all optical errors of the image are also enlarged a hundred-fold, the contours grow vague and so on. The accuracy of the projected image is only deceptive. Lengths smaller than $\frac{1}{2}$ wavelength of light (0·2-0·3 $\mu$) are not shown true to life and are not measurable, whilst on an enormously enlarged projected image, measuring is apparently possible with an accuracy up to 0·05 lb. and even more "accurately." It cannot be denied that an efficient micro-projector

is of great value for showing slides objectively to an audience, for drawing or in order to use the planimeter, but for measuring linear lengths it functions no better than any good microscope. For measuring, a projector can therefore be discarded and an ordinary microscope will suffice.

Further it is important how the yield of the trees is determined. In Ashplant's correlation tables the trees are classified according to their latex yield in cubic centimeters. But since for selection purposes the production of dry rubber, which is often not proportional to the latex yield, plays a prominent part. It seems more accurate to judge the trees according to their yield of dry rubber.

Ashplant maintains silence as to the micro-technique with the exception of a remark that only longitudinal selections can be used. It is necessary therefore to work out an independent method. For this investigation 2 methods were tried on material fixed in alcohol (70%).

1. Schulze's maceration method.
2. The eau de Javelle method.

Since the method used by Ashplant is not known, unfortunately comparisons of the figures derived from this investigation with those of Ashplant are necessarily subject to qualification, especially since the yield measurements are based on another principle. The object of this investigation is therefore restricted to investigating the existence of a correlation between rubber production and latex tube diameter.

4. *Objections to the maceration method for the purpose of measuring.* —Although the maceration method is admirably suited to the study of the course of the latex tubes in the bark and for counting the rings, it cannot however come under consideration for the purpose of measuring, since the tubes swell as a result of the treatment and, later on, when the sections are stored in glycerine, gradually become thicker. This is proved by a comparison with measurements of sections treated with eau de Javelle (table I). The sections are derived from the same bark sample; the figures are the average of 100 measurements each.

**Table I**

*Comparison between the maceration and eau de Javelle methods*

| Position of the trees in Soengei Pantjoer | | | Diameter of the latex tubes of the bark in μ | |
|---|---|---|---|---|
| | | | Maceration method | eau de Javelle method |
| Block | Row | Tree | | |
| crosses 165 × 161 | | | | |
| 8 | 6 | 1 | 26·7 ± 0·30 | 23·8 ± 0·20 |
| 8 | 6 | 4 | 28·2 ± 0·53 | 27·0 ± 0·36 |
| 8 | 6 | 6 | 27·9 ± 0·36 | 24·7 ± 0·26 |
| marcots clone 180 | | | | |
| 9 | 14 | 8 | 25·6 ± 0·34 | 22·9 ± 0·28 |
| 9 | 14 | 10 | 27·6 ± 0·48 | 23·3 ± 0·25 |
| 9 | 14 | 12 | 26·6 ± 0·38 | 22·7 ± 0·27 |

It appears from table I, that the macerated sections have much broader latex tubes than those obtained by eau de Javelle procedure; further the maceration method results in considerably large standard deviations.

The trees from block 8 are seedlings from the cross 165 × 161 (see section 8a) and the three trees from block 9 are marcots from clone 180. According to the third hypothesis mentioned in the introduction the latter should have the same width of latex tubes. Whilst this is more or less the case, within the limits of the standard deviation, for the sections treated with eau de Javelle, such a relation cannot be concluded from the maceration method.

After one month a few measurements on the same sections were repeated; the tubes treated according to Schulze appeared to have swollen still more:

| Block | Row | Tree | 1st measurement | 2nd measurement |
|---|---|---|---|---|
| 9 | 14 | 8 | 25·6 ± 0·34 | 27·1 ± 0·53 |
| 9 | 14 | 12 | 26·6 ± 0·38 | 28·0 ± 0·38 |

In the sections treated with eau de Javelle only variations within the limits of the standard deviation were found.

It appears from these facts, that the maceration method is impracticable for accurate measurements, whilst on the contrary the eau de Javelle method can be used, if measuring is done within one month. This being always feasible, investigation along this line was discontinued.

In order to know the diameter of the latex tubes measuring shoold be done from cell wall to cell wall. Now this is very difficult if only the cell content is coloured and when hundreds of measurements must be recorded this work is a strain on the eyes. Especially with the maceration method, when the cell walls are nearly indiscernible, the coagulated cell content is measured involuntarily instead of the diameter. But the coagulated rubber is irregularly withdrawn from the cell wall so that the figures found for the diameter of the latex tubes are too small. Sections treated with eau de Javelle can be used much better for staining the cell walls than those treated with potassium chlorate, as the latter disintegrate easily because the tissues no longer cohere.

5. *The method employed for the present investigation.*—After the preliminary investigation had shown that the eau de Javelle method yields better results than the maceration method and that staining of the cell wall is necessary, the following technique was developed. The sections, which should not be too thin (otherwise the latex tubes are torn), are cut with a gliding microtome and treated as follows:

Bleached in eau de Javelle for 1 hour,
Stained in Delafield's haematoxyline for 5 minutes (or less),
Rinsed in water and immersed in glycerine,
Stained in Sudan III for ½ hour,
Rinsed in glycerine.

Eau de Javelle, being unstable in the tropics, is prepared and continually kept fresh in the following manner: chroline is generated from pyrolusite and concentrated hydro-chloric acid and led through a dilute solution of potassium hydroxide (10-15%). Since chlorine is liberated at tropical temperatures heating is not necessary. In this way it is possible to obtain a slight and fairly regular flow of chlorine from granulated pyrolusite (manganese dioxide), which is led day and night through the potash lye in a fumecupboard. In this way a strong eau de Javelle is always available, bleaches the sections within one hour.

Sudan III is prepared according to the formula of Bobilioff and Delafield's haematoxyline according to Strausburgher.

When the sections are satisfactorily stained the walls of the tubes are intense blue and the coagulated cell content a brilliant red. It is then clearly seen that the cell content is irregularly withdrawn from the cell wall. Therefore alcohol (70-90%) is not an ideal fixative for the system of latex tubes. The whole cavity was always measured from cell wall to cell wall.

6. *Anatomy of the petiole of Hevea.*—Preparatory to carrying out measurements on a large scale an investigation into the anatomy of the petiole was considered indispensable, since that is missing in Bobilioff's paper and Asphlant has not investigated whether the system of latex tubes in the bark of the stem is different; neither does he mention that two kinds of latex tubes occur in the leafstalk.

It follows from the anatomical investigation, that only the tubes between the tissue of the pericycle and the wood cells should be considered for measuring. Since these tubes have been formed in a different manner (according to their origin they are to be considered proto—or metaphloëm elements) to the latex tubes of the stem bark (secondary phloëm elements), it is anatomically incorrect off hand to consider the former equivalent to the latter.

## 3. MEASUREMENTS MADE

A Zeiss microscope with objective D (=40) and compensating ocular 18 as ocular micrometer were used for measuring. One interval of the micrometer corresponded to 4·7 μ. Since the diameter of the latex tubes varies considerably, it was especially necessary to know the number of measurements required for a reliable average. Ashplant used the average of 120 measurements; but since he does not give standard deviations, no idea of the extent of the variation of the diameters of the tubes is obtainable. Each of the figures in the following tables is the average of 100 measurements; it appears from the standard deviations that this number is sufficient. Quite valueless averages would be obtained, however, if, in order to save time, less numerous measurements were taken, for instance 10. In this case the standard deviation would increase threefold, so that the averages in table II would not represent an actual difference.

7. *Measurements in leafstalks of buddings of known clones.*—Of course the most remarkable statement of Ashplant, that seedlings scarcely 6 months old with large tubes will become good yielders when tappable, is impossible of verification at present. On the other hand this could be done with 6 months old buddings from known clones. For this purpose leaves were harvested in the nurseries from the AVROS-clones mentioned in tables II and III, fixed in alcohol and after a few days treated as described in section 5. In order to get comparable material the lowest leaves from full-grown internodes were chosen exclusivley.

6 to 10 sections were put on a slide in glycerine. Of course sections which have been cut somewhat tangentially contain more tubes than true radial sections. To begin with, an investigation was carried out to discover whether 100 measurements, made repeatedly in the same preparation, always resulted in the same average.

This preliminary investigation was carried out with two clones and resulted in the following data (see table II):

| Clone | | Average of the 1st-100th measurement | Average of the 101st-200th measurement |
|---|---|---|---|
| 152 | ... | $17{\cdot}6 \pm 0{\cdot}25\ \mu$ | $17{\cdot}7 \pm 0{\cdot}34\ \mu$ |
| 180 | ... | $18{\cdot}1 \pm 0{\cdot}33\ \mu$ | $18{\cdot}2 \pm 0{\cdot}34\ \mu$ |

The averages of each 100 measurements are seen to agree with the limits of the standard deviation.

In order to give an idea of the variations in width of the latex tubes in the leafstalk (and analogously also in the bark), the distribution of each 100 measurements is given in table II arranged in classes of $\frac{1}{2}$ micrometer divisions.

When all measurements in each class are added up, figures are obtained which correspond with a fairly regular Galton's curve. Consequently the material examined does not contain many very large or very small tubes.

In table II the clones are ranked according to the diameter of the latex tubes; the differences are not very marked. But it is very curious, that our contra selection tree, clone 180, which scarcely yields any latex when tapped, possesses the same diameter as clone 36, one of the highest-yielding clones. Unfortunately we do not possess more poor but well-known clones to determine whether this is only a fortuitous exception.

Comparing the diameters with the yields of the various clones, a good correlation is not found (table III). It is true the good clones 256 and 71, as well as the promising clones 183 and 214 head table II, but on the other hand the rather widely varying clones 33, 80, 152 and 163 have the same diameter of the latex tubes, whilst the good clones 49 and 50 come at the bottom of the list and below the indifferent clone 35.

## Table II

*Distribution of frequency of 100 measurements of the diameter of the latex tubes in leafstalks of known clones. 1 division (d) of the micrometer = 6·7 μ*

| Clone | d= 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 | 5½ | Number of measurements | Average in d | Average in μ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | μ= 9·4 | 11·7 | 14·1 | 16·4 | 18·4 | 21·1 | 23·5 | 25·8 | | | |
| 256 | — | 2 | 9 | 17 | 31 | 22 | 15 | 4 | 100 | 4·11±0·068 | 19·3±0·032 |
| 183 | — | 2 | 13 | 20 | 27 | 26 | 12 | — | 100 | 3·99±0·064 | 18·8±0·30 |
| 71 | — | 1 | 10 | 26 | 35 | 16 | 10 | 2 | 100 | 3·96±0·062 | 18·6±0·29 |
| 214 | — | 2 | 15 | 23 | 33 | 16 | 10 | 1 | 100 | 3·90±0·064 | 18·3±0·30 |
| 36 | — | 2 | 14 | 32 | 33 | 14 | 5 | — | 100 | 3·79±0·056 | 17·8±0·27 |
| 152 | — | — | 22 | 26 | 37 | 12 | 3 | — | 100 | 3·74±0·053 | 17·6±0·25 |
| | — | 6 | 17 | 30 | 23 | 14 | 8 | 2 | 100 | 3·77±0·070 | 17·7±0·34 |
| 163 | — | 1 | 16 | 37 | 33 | 11 | 2 | — | 100 | 3·71±0·049 | 17·5±0·23 |
| 80 | — | 1 | 20 | 33 | 32 | 9 | 5 | — | 100 | 3·71±0·055 | 17·5±0·26 |
| 33 | 1 | 5 | 22 | 24 | 27 | 14 | 7 | — | 100 | 3·70±0·067 | 17·4±0·32 |
| 35 | — | 2 | 17 | 38 | 32 | 10 | 1 | — | 100 | 3·67±0·049 | 17·3±0·23 |
| 49 | 2 | 9 | 29 | 24 | 19 | 15 | 2 | — | 100 | 3·51±0·067 | 16·5±0·32 |
| 50 | — | 5 | 29 | 34 | 28 | 4 | — | — | 100 | 3·48±0·048 | 16·4±0·23 |
| | 3 | 38 | 233 | 364 | 390 | 183 | 80 | 9 | 1300 | | |
| Contra selection tree 180 | — | 5 | 17 | 21 | 30 | 15 | 10 | 2 | 100 | 3·85±0·071 | 18·1±0·33 |
| | — | 7 | 16 | 20 | 24 | 20 | 13 | — | 100 | 3·85±0·073 | 18·2±0·34 |
| | — | 12 | 33 | 41 | 54 | 35 | 23 | 2 | 200 | | |
| Total | 3 | 50 | 266 | 405 | 444 | 218 | 103 | 11 | 1500 | | |

## Table III

*Comparison between the yield of known clones (according to Heusser) and the diameter of the latex tubes of the leaf-stalk of 6 months old buddings.*

| Clone | Number of trees | Grams of dry rubber per tapping year of tapping. 1 | 2 | 3 | 4 | 5 | 6 | Diameter of the latex tubes of the leafstalk | Position of the trees |
|---|---|---|---|---|---|---|---|---|---|
| 33 | 11 | 5·5 | 11·2 | 23·8 | 27·6 | 29·9 | 31·8 | 17·4 ± 0·23 μ | Seed garden |
| 35 | 226 | 6·8 | 16·3 | 18·3 | 21·7 | 26·5 | — | 17·3 ± 0·23 ,, | Tjinta Radja |
| 36 | 10 | 4·2 | 10·0 | 20·3 | 24·8 | 33·2 | 41·4 | 17·8 ± 0·27 ,, | Seed garden |
| 49 | 109 | 6·2 | 14·5 | 21·3 | 25·6 | 30·7 | — | 16·5 ± 0·32 ,, | Tjinta Radja |
| 50 | 9 | 6·1 | 14·7 | 30·3 | 34·0 | 29·5 | 31·1 | 16·4 ± 0·23 ,, | Seed garden |
| 71 | 100 | 7·8 | 12·8 | 21·8 | — | — | — | 18·6 ± 0·29 ,, | Boekit Maradja |
| 80 | 50 | 6·3 | 12·1 | 15·2 | — | — | — | 17·5 ± 0·26 ,, | Boekit Maradja |
| 152 | 100 | 9·7 | 17·1 | 23·6 | — | — | — | 17·6 ± 0·25 ,, | Boekit Maradja |
| 163 | 50 | 7·8 | 12·7 | 20·8 | — | — | — | 17·5 + 0·23 ,, | Boekit Maradja |
| 183 | 6 | 14·8 | 24·0 | — | — | — | — | 18·8 ± 0·30 ,, | Soengei Pantjoer |
| 214 | 10 | 15·2 | — | — | — | — | — | 18·3 ± 0·30 ,, | Soengei Pantjoer |
| 256 | 20 | — | — | — | 41·7 | — | — | 19·3 ± 0·32 ,, | Temiang |
| Contra selection tree 180 | 26 | 0·6 | 1·3 | — | — | — | — | 18·1 ± 0·33 ,, | Soengei Pantjoer |

Ashplant says that all clones from Java, which he examined showed very wide latex tubes; from correlation table VI it appears however, that the diameters of the latex tubes of the examined clones are not very outstanding, with exception of clone 256. The variability in yield of the clones now examined, with exception of the contra selection tree 180, is too small to allow conclusions to be drawn from the figures, the less so since the clones have been tested in different places so that the yield records are not strictly comparable. Therefore the investigation was extended to seedlings of the most widely varying yield classes.

The small variation in yield of the clones coincides with a small variation in the diameters of the latex tubes. It only amounts to 16·4-19·3 μ (as against 14·4-21·2 μ for the seedlings examined, see tables IV and V) whilst nearly all are classed in the groups of 17 and 18 μ (see table VI). Taking into consideration the relatively large standard deviations, which allow only differences of more than 0·5 μ to be considered real differences, judging the clones examined according to the diameter of the tubes (excepted perhaps clone 256) seems to be without prospects.

8. *Measurements of latex tubes of seedlings in leafstalk and bark.*— Investigation of tappable seedlings cannot decide the most important problem, to wit, whether Ashplant's method of selection is applicable to nurseries. On the other hand comparative measurements can be carried out in leafstalks and bark, and the correlation between "yield and number of rings of latex tubes" can be contrasted with that between "yield and diameter of the latex tubes."

Leaves were therefore harvested from each tree and at the same time samples were taken of virgin bark at a height of I M. The sections of the bark were cut exclusively from the "productive" zone (see section 10), since according to Ashplant a considerable difference exists between the diameter of the latex tubes near the cambium and that of the tubes in the outer zone.

All the seedlings examined were planted in October 1921 as 1-year-old stumps and for the greater part were in the third year of tapping in 1928; all are growing in the Soengei Pantjoer selection garden and their positions are given in the tables.

In tables IV and V the averages of the measurements are calculated at Soengei Pantjoer according to block, row, and tree of the trees examined; for instance 8/12/6 means the sixth tree in row of 12 of block 8. In the following correlation tables (VI-X) all trees are described in the same way; this simplifies looking up the same tree in the various tables. Columns 2 and 3 give the averages of the 100 measurements of tubes in leafstalk and bark with the respective standard deviations. Column 4 gives the ratio between the diameters of the tubes of leafstalk and bark. Columns 5 and 6 give the yield (grammes of dry rubber per tapping) column 5 the average of all three tapping years, and column 6 the average of 1928 (150 tapping days). For the compilation of the correlation tables VI-X the averages of 1928 have been used exclusively since otherwise no comparison with the correlation between number of rings and yield would have been possible, nor could a calculation of the yield per productive ring have been made, because the bark samples taken in the beginning of 1929, can only be used for judging the bark during the last tapping period.

Columns 7 to 10 comprise the number of rings of latex tubes of the bark as specified in section 10. In column 11 the yield of one productive ring has been calculated, and in column 12 that of 1 cm. of productive ring by means of the girth measurements at a height of 1 M., given in column 13; it must be noted that only 1/3 of the circumference is being tapped.

In the last column (14) the crossings have been mentioned which were chosen as new mother trees, or which have not yet been tapped for three years for some reason or other (slow growth in thickness etc.). These trees have also been measured in this investigation in order to get a greater variation of yield and circumference. If very divergent figures had been obtained from these trees, tending to obscure the results, it would have been necessary to omit them, but since they do not fall beyond, but within, the limits of the good growers and partly (such as trees 43/2/1 and 43/2/2 in tables VI and VIII) contributed to an improvement of the correlation, they have been inserted in the correlation tables VI-X.

a. *Crosses of the family 165 × 161.*—Widely varying yielders are found amongst the crosses of mother tree 165 with No. 161 as father tree. Unfortunately only 4 trees of this cross have reached tappable age, and one is so backward, that it is not considered in this investigation. It appears from table IV, that the large differences in yield coincide with an appreciable variation of the diameter of the latex tubes. Of all examined trees, tree 8/6/4 which has been chosen as a new mother tree 317, has the widest latex tubes (and also for that matter the greatest number of productive rings).

b. *Crosses of the family 157 × 166.*—In the second place 12 trees of cross 157 × 166 with as widely varying yields as possible were measured. Two of these trees have been chosen as new mother tree on account of the satisfactory yield (8/12/11 = mother-tree 292 and 8/12/4 = mother-tree 293); their latex tubes do not stand out with a very large diameter.

c. *Kampong trees.*—An insufficient number of poor yielders occurring amongst the artificial crosses, measurements were taken of 14 of the kampong trees which have been planted in Soengei Pantjoer for comparative purposes. Trees 43/2/1, 43/2/2 and 43/2/9 are backward, or for other reasons have been tapped only one year.

9. *Results of the measurements of the diameter of the latex tubes.*—The ratio between the latex tubes of the leafstalks and those of the bark yields the most important results. Ashplant takes for granted that trees with large tubes in the bark also possess large tubes in the leafstalk, but this assumption is not substantiated by a single figure. According to a report of a planters' meeting the existence of such a correlation would be immaterial to him.

## Table IV

*Diameter of the latex tubes and of yield artificially crossed trees.*

| Position in Soengei Pantjoer block/row/tree 1 | Diameter of the latex tubes in μ: leafstalk 2 | Diameter of the latex tubes in μ: bark 3 | Ratio leafstalk/bark 4 | Production in grammes of dry rubber per tapping: 1926/28 5 | Production in grammes of dry rubber per tapping: 1928 6 | Number of rings of latex tubes: total 7 | Number of rings of latex tubes: within 1·0 m.m 8 | Number of rings of latex tubes: productive 9 | Number of rings of latex tubes: hard bark 10 | Production 1928 of: 1 productive ring 11 | Production 1928 of: 1 cm productive ring 12 | Circumference at 1 m height in cm. 13 | Remarks 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cross 157 × 166 | | | | | | | | | |
| 8/12/1 | 16·4±0·19 | 26·3±0·35 | 0·63 | 15·6 | 23·7 | 27 | 6 | 17 | 4 | 1·39 | 0·055 | 76 | — |
| 2 | 18·3±0·15 | 26·6±0·31 | 0·69 | 12·5 | 17·0 | 37 | 15 | 16 | 6 | 1·06 | 0·045 | 71 | — |
| 3 | 16·1±0·19 | 26·5±0·33 | 0·61 | 16·6 | 19·2 | 37 | 12 | 19 | 6 | 1·01 | 0·035 | 81½ | — |
| 4 | 18·2±0·21 | 26·9±0·34 | 0·68 | 24·4 | 34·6 | 36 | 12 | 20 | 4 | 1·73 | 0·065 | 79½ | Mother-tree |
| 5 | 16·3±0·15 | 27·3±0·34 | 0·60 | 23·1 | 28·8 | 38 | 13 | 23 | 2 | 1·25 | 0·056 | 66½ | — |
| 6 | 17·3±0·22 | 26·4±0·42 | 0·66 | 26·5 | 32·5 | 31 | 12 | 17 | 2 | 1·91 | 0·079 | 73 | — |
| 7 | 17·4±0·17 | 24·8±0·38 | 0·70 | 22·9 | 34·9 | 23 | 9 | 12 | 2 | 2·91 | 0·140 | 62½ | |
| 8 | 17·5±0·23 | 25·7±0·38 | 0·68 | 21·9 | 32·0 | 23 | 10 | 11 | 2 | 2·91 | 0·127 | 68½ | |
| 9 | 17·0±0·19 | 25·3±0·35 | 0·67 | 14·7 | 20·0 | 28 | 11 | 13 | 4 | 1·54 | 0·070 | 66 | |
| 10 | 17·7±0·20 | 25·6±0·27 | 0·69 | 24·1 | 32·7 | 24 | 10 | 11 | 3 | 2·98 | 0·144 | 62 | |
| 11 | 17·4±0·24 | 25·1±0·31 | 0·69 | 36·6 | 49·3 | 33 | 9 | 21 | 3 | 2·35 | 0·085 | 83 | — |
| 14 | 17·8±0·30 | 24·6±0·28 | 0·72 | 5·4 | 6·0 | 24 | 10 | 12 | 2 | 0·50 | 0·036 | 41½ | Mother-tree 292 Tapped 2 years only |
| | | | | Cross 165 × 161 | | | | | | | | | |
| 8/6/1 | 17·6±0·29 | 23·8±0·20 | 0·74 | 9·1 | 12·2 | 24 | 7 | 14 | 3 | 0·87 | 0·031 | | |
| 4 | 21·2±0·28 | 27·0±0·36 | 0·78 | 51·3 | 91·9 | 36 | 8 | 24 | 4 | 3·82 | 0·141 | | Mother-tree 317 |
| 6 | 17·2±0·34 | 24·7±0·26 | 0·70 | 12·2 | 19·7 | 20 | 88 | 10 | 2 | 1·97 | 0·095 | | |

## Table V

*Diameter of the latex tubes and yield of Kampong trees.*

| Position in Soengei Pantjoer block/row/ree 1 | Diameter of the latex tubes in μ | | Ratio leafstalk/bark 4 | Production in grammes of dry rubber per tapping | | Number of rings of latex tubes | | | Production 1928 of | | | Circumference at 1 m height in cm 13 | Remarks 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | leafstalk 2 | bark 3 | | 1926/28 5 | 1928 6 | total 7 | within 1.6 mm 8 | productive 9 | hard bark 10 | 1 productive ring 11 | 1 cm productive ring 12 | | |
| 43/2/1 | 14·4±0·27 | 25·8±0·27 | 0·56 | 3·3 | 3·3 | 15 | 7 | 5 | 3 | 0·66 | 0·035 | 57½ | Tapped 1 year only |
| 2 | 15·8±0·26 | 25·6±0·23 | 0·62 | 2·1 | 2·1 | 12 | 7 | 2 | 2 | 1·05 | 0·056 | 56 | Tapped 1 year only |
| 3 | 18·2±0·31 | 21·9±0·23 | 0·83 | 6·8 | 8·8 | 18 | 5 | 11 | 2 | 0·80 | 0·029 | 84 | — |
| 4 | 15·7±0·23 | 22·8±0·24 | 0·69 | 5·5 | 7·0 | 24 | 10 | 12 | 2 | 0·58 | 0·029 | 60 | — |
| 5 | 14·5±0·25 | 22·2±0·25 | 0·65 | 5·0 | 5·2 | 15 | 5 | 8 | 2 | 0·65 | 0·026 | 76 | — |
| 6 | 19·1±0·31 | 26·0±0·33 | 0·73 | 4·7 | 7·7 | 19 | 9 | 8 | 2 | 0·96 | 0·044 | 66 | — |
| 7 | 17·2±0·28 | 22·6±0·24 | 0·76 | 6·5 | 8·0 | 18 | 7 | 9 | 2 | 0·88 | 0·040 | 66½ | — |
| 8 | 17·7±0·35 | 24·6±0·28 | 0·72 | 7·0 | 6·8 | 18 | 5 | 9 | 4 | 0·75 | 0·026 | 87½ | — |
| 9 | 17·0±0·30 | 25·0±0·25 | 0·68 | 5·3 | 5·3 | 21 | 7 | 12 | 2 | 0·44 | 0·017 | 76 | Tapped 1 year only |
| 10 | 16·2±0·28 | 24·7±0·23 | 0·66 | 7·2 | 9·2 | 26 | 11 | 10 | 5 | 0·92 | 0·031 | 88 | — |
| 11 | 14·9±0·26 | 23·6±0·25 | 0·63 | 5·1 | 7·4 | 15 | 5 | 8 | 2 | 0·92 | 0·041 | 66½ | — |
| 12 | 18·2±0·33 | 24·3±0·27 | 0·75 | 12·5 | 19·2 | 26 | 12 | 12 | 2 | 1·60 | 0·079 | 60½ | — |
| 13 | 16·7±0·24 | 24·2±0·21 | 0·69 | 4·4 | 3·6 | 15 | 4 | 7 | 4 | 0·51 | 0·021 | 73 | — |
| 14 | 17·4±0·27 | 25·4±0·25 | 0·68 | 2·3 | 3·3 | 16 | 5 | 9 | 2 | 0·36 | 0·018 | 61½ | - |

As appears from tables IV and V (column 4) the assumption is correct with certain limits. But all the same variation from 0·56 to 0·83, or 32·5%, in the ratio diameter of leafstalk tube 1 diameter of bark tube in table V is noteworthy, whilst table IV shows a more constant ration (variation 0·61 to 0·78). The average of all 29 relative figures is 0·689 ± 0·010; this is therefore the factor for an approximate calculation of the diameters in the leafstalk from those in the bark or vice versa.

Compiling correlation tables from the data in the tables IV, and V, a striking correlation between the diameter of the latex tubes and the yield is not found. Correlation table VI represents the measurements of leafstalks in correlation with the yield. The data concerning buddings from table III have also been used for the compilation of this table, using the yields of the third year of tapping, as with the examined seedlings. For clones 180, 183, 214 and 256, yield measurements not being available for the third tapping year, the yields are extrapolated. The seedlings are indicated by their position in Soengei Pantjoer (for mother-trees the selection number is also given in parenthesis), whilst the clone numbers are indicated by cl.

Correlation table VII gives the diameter of the bark tubes. Here again the correlation is bad. Comparison of correlation table VII with correlation table VIII, in which the number of rings of latex tubes has been compiled, is not in favour of the former. As it was the object of this investigation to find a better correlation for the identification of good yielders than the usual, unsatisfactory correlation between yield and number of latex tubes, it seemed only a loss of time to continue the measurements. Rather a better arrangement of the data gathered thus far should be attempted and the fundamental idea of Ashplant and the considerations set forth in section 2 should be probed for possible fundamental errors.

10. *Rings of productive tubes.*—First an attempt was made to calculate the yield per tapped ring of latex tubes, as done by Ashplant in his second correlation table.

Taking into consideration only the productive rings, *i.e.*, the rings which are actually opened by tapping and contain latex which can flow out, should result in a better correlation. Haigh has also drawn attention to the fact that the bark zone of ± 1·6 mm. near the cambium is not touched by the tapping knife. But in the actually tapped bark there are also rings which do not yield since the contents are coagulated. Haigh tried to investigate this by means of a micro-chemical process, but this yielded peculiar results. Perhaps it would be better to ascertain this from physiological considerations. Bobilioff has already drawn attention to the fact that the tubes in the hard bark are in less favourable condition than those in the soft bark. According to Zimmermann and Arisz the latex tubes, when tapped must absorb water. This water is supplied from the wood through the medullary rays. It is evident, therefore, that a tube which is separated from the soft bark by a closed sclerenchymatous ring cannot function normally since the water supply is interrupted. In the same way rings, which are interrupted by sclerenchyma do not function well, since the change of turgor in the mantle of latex tubes, caused by the tapping cannot be evenly transmitted through the whole system of tubes. The latex flow from such tubes will therefore gradually decrease to nil; besides, it can be seen also when the tapping is very shallow, that the latex in the outer rings is coagulated.

In this treatise, therefore, as productive rings are considered those rings, which are situated between 1·6 mm. from the cambium and those which are interrupted or totally separated from the soft bark by sclerenchyma (see columns 7-10 in tables IV and V).

Table VI

*Correlation between yield (3rd year of tapping) and diameter of the latex tubes of the leafstalk.*
*Correlation coefficient $+0{\cdot}54 \pm 0{\cdot}11$. Yield in grammes of dry rubber per tapping.*

| Diameter of the latex tubes of the leafstalk in μ | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 43/2/1 | 43/2/5<br>43/2/11 | | | | | | | | | | | | | | | | | | 3 |
| 15 | 43/2/2 | 43/2/4 | | | | | | | | | | | | | | | | | | 2 |
| 16 | 43/2/13 | 43/2/10 | | 8/12/3 | 8/12/1<br>cl. 49 | 8/12/5 | cl. 50 | | | | | | | | | | | | | 7 |
| 17 | 43/2/14 | 8/12/14<br>43/2/7<br>43/2/8<br>43/2/9 | 8/6/1 | 8/6/6<br>cl. 35<br>cl. 80 | 8/12/9<br>cl. 33<br>cl. 36<br>cl. 152<br>cl. 163 | | 8/12/6<br>8/12/7<br>8/12/8<br>8/12/10 | | | 8/12/11<br>(=292) | | | | | | | | | | 19 |
| 18 | cl. 180 | 43/2/3 | | 8/12/2<br>43/2/12 | cl. 71 | cl. 214 | 8/12/4<br>(=293<br>cl. 183 | | | | | | | | | | | | | 8 |
| 19 | | 43/2/6 | | | | | cl. 256 | | | | | | | | | | | | | 2 |
| 20 | | | | | | | | | | | | | | | | | | | | 0 |
| 21 | | | | | | | | | | | | | | | | | | | 8/6/4<br>(=317) | 1 |
| | 5 | 10 | 1 | 6 | 8 | 2 | 8 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 42 |

## Table VII

*Correlation between yield (3rd year of tapping) and diameter of the latex tubes of the bark. Correlation coefficient +0 49 ± 0 14. Yield in grammes of dry rubber per tapping.*

| Diameter of the latex tubes of the bark in μ | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | | 43/2/3 | | | | | | | | | | | | | | | | | | 1 |
| 22 | | 43/2/4<br>43/2/5<br>43/2/7 | | | | | | | | | | | | | | | | | | 3 |
| 23 | | 43/12/11 | 8/6/1 | | | | | | | | | | | | | | | | | 2 |
| 24 | 43/2/13 | 8/12/14<br>43/2/8<br>43/2/10 | | 8/6/6<br>43/2/12 | | | 8/12/7 | | | | | | | | | | | | | 7 |
| 25 | 43/2/1<br>43/2/3 | 43/2/9 | | | 8/12/9 | | 8/12/8<br>8/12/10 | | | 8/12/8<br>=292) | | | | | | | | | | 8 |
| 26 | | 43/2/6 | | 8/12/2<br>8/12/3 | 8/12/1 | | 8/12/4<br>(=293)<br>8/12/6 | | | | | | | | | | | | | 6 |
| 27 | | | | | | | | | | | | | | | | | | | 8/6/4<br>(=317) | 2 |
| | 4 | 10 | 1 | 4 | 2 | 1 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 29 |

## Table VIII

*Correlation between yield (3rd year of tapping) and number of productive rings of latex tubes. Correlation coefficient $+0{\cdot}75 \pm 0{\cdot}8$. Yield in grammes of dry rubber per tapping.*

| Number of productive rings of latex tubes at 1 M height | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 43/2/2 | | | | | | | | | | | | | | | | | | | 1 |
| 4 | 43/2/1<br>43/2/13 | | | | | | | | | | | | | | | | | | | 2 |
| 8 | 43/2/14 | 43/2/3<br>43/2/5<br>43/2/6<br>43/2/7<br>43/2/8<br>43/2/10<br>43/2/11 | | 8/6/6 | | | 8/12/8<br>8/12/10 | | | | | | | | | | | | | 11 |
| 12 | | 8/12/14<br>43/2/4<br>43/2/9 | 8/6/1 | 43/2/12 | 8/12/9 | | 8/12/7 | | | | | | | | | | | | | 7 |
| 16 | | | | 8/12/2<br>8/12/3 | 8/12/1 | | 8/12/6 | | | | | | | | | | | | | 4 |
| 20 | | | | | | 8/12/5 | 8/12/4<br>(=293) | | | 8/12/11<br>(=292) | | | | | | | | | | 3 |
| 24 | | | | | | | | | | | | | | | | | | | 8/6/4<br>(=317) | 1 |
| | 4 | 10 | 1 | 4 | 2 | 1 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 29 |

The correlation between the diameters of the latex tubes should be improved by the calculation of the yield per productive ring since the dynamical considerations of section 2 do not apply to the other rings. Further the influence of the differences in the circumsference can be eliminated by dividing the yields per productive ring, corresponding with the length of the tapping cut, by 1/3 of the circumference; in this way the yield per 1 cm. of productive ring is obtained. In this manner the factors (n') and (o) are eliminated from equation (3) and consequently the influence of the diameter, which occurs in the fourth power, should be increasingly manifested.

The correlation tables IX and X contain the data calculated in this way. The measures taken have not improved the correlation, on the contrary, as more changeable factors are eliminated, the correlation becomes worse. This appears from tables VII, IX and X and the following table in which, besides the correlations of the tables VI-X, the correlation coefficients between the diameters of the tubes of the leafstalk and the converted production figures have also been inserted.

In connection with the large standard deviations there is no real difference between these diameter correlation coefficients. Nevertheless it is noteworthy that they become systematically smaller and the standard deviations increase proportionally when trying to improve the correlation by calculation of the yield per productive ring or per 1 cm. productive ring. This in contradiction to what might have been expected, and also with Ashplant's results, who, when calculating the yield per productive ring according to his method, finds a considerably better correlation (+0·83) than for the total yield (+0·76).

Table IX

*Correlation between the yield of one productive ring and the diameter of the latex tubes of the bark. Correlation coefficient $+0{\cdot}41 \pm 0{\cdot}15$. Yield (grammes of dry rubber per tapping) per productive ring.*

| Diameter of the latex tubes of the bark in μ | 0·2 | 0·4 | 0·6 | 0·8 | 1·0 | 1·2 | 1·4 | 1·6 | 1·8 | 2·0 | 2·2 | 2·4 | 2·6 | 2·8 | 3·0 | 3·2 | 3·4 | 3·6 | 3·8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | | | | 43/2/3<br>32/2/7 | | | | | | | | | | | | | | | | 1 |
| 22 | | 43/2/4 | 43/2/5 | | | | | | | | | | | | | | | | | 3 |
| 23 | | | | 8/6/1<br>43/2/11 | | | | | | | | | | | | | | | | 2 |
| 24 | | 8/12/14<br>43/2/13 | 43/2/8 | 43/2/10 | | | | 43/2/12 | 8/6/6 | | | | | 8/12/7 | | | | | | 7 |
| 25 | 43/2/14 | 43/2/9 | 43/2/1 | | 43/2/2 | | 8/12/9 | | | | 8/12/11<br>(=292) | | | 8/12/8<br>8/12/10 | | | | | | 8 |
| 26 | | | | 43/2/6 | 8/12/2<br>8/12/3 | 8/12/1 | | 8/12/4<br>(=293) | 8/12/6 | | | | | | | | | | | 6 |
| 27 | | | | | | 8/12/5 | | | | | | | | | | | | | 8/6/4<br>(=317) | 2 |
| | 1 | 4 | 3 | 6 | 3 | 2 | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 29 |

## Table X

*Correlation between the yield per 1 cm. productive ring and the diameter of the latex tubes of the bark. Correlation coefficient + 0·36 ± 0·16. Yield (grammes of dry rubber per tapping) per 1 cm. productive ring.*

| Diameter of the latex tubes of the bark in μ | 0·014 | 0·021 | 0·028 | 0·035 | 0·042 | 0·049 | 0·056 | 0·063 | 0·070 | 0·077 | 0·084 | 0·091 | 0·098 | 0·105 | 0·112 | 0·119 | 0·126 | 0·133 | 0·140 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | | | 43/2/3 | | | | | | | | | | | | | | | | | 1 |
| 22 | | 43/2/5 | 43/2/4 | 43/2/7 | | | | | | | | | | | | | | | | 3 |
| 23 | | | 8/6/1 | 43/2/11 | | | | | | | | | | | | | | | | 2 |
| 24 | | 43/2/8 | 43/2/10 | | | | | | | | | | | | | | | | | |
| | | 43/2/13 | | 8/12/14 | | | | | | 43/2/12 | | 8/6/6 | | | | | | | 8/12/7 | 7 |
| 25 | 43/2/9<br>43/2/14 | | | 43/2/1 | | | 43/2/2 | | 8/12/9 | | 8/12/11<br>(=292) | | | | | | 8/12/8 | | 8/12/10 | 8 |
| 26 | | | | 8/12/3 | 8/12/2<br>43/2/6 | 8/12/1 | | 8/12/4<br>(=293) | | 8/12/6 | | | | | | | | | | 8 |
| 27 | | | | | | | 8/12/5 | | | | | | | | | | | | 8/6/4 | 2 |
| | 2 | 3 | 4 | 5 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 29 |

| Correlation between | Production 1928 | Production 1928, of one productive ring | Production 1928 of I cm Productive ring |
|---|---|---|---|
| Diameter of the latex tubes of the leafstalk | +0·50±0·11 | +0·50±0·14 | +0·44±0·15 |
| Diameter of the latex tubes of the bark | ×0·49±0·14 | +0·41±0·15 | +0·36±0·16 |
| Number of productive rings of latex tubes | +0·75±0·08 | — | — |

On the other hand it is found, in agreement with Ashplant, that the leafstalk gives a better correlation than the bark. This is rather strange, since the latex must flow through the tubes of the bark and not through the leafstalk. If other investigators also find a better correlation for the leafstalk, then Ashplant has indeed found a very remarkable relation between anatomy and yield, which will not be easily explainable. Ashplant considers the bark unsuitable for measurements since he could not find a constant diameter in the bark. By measuring exclusively in the productive zone constant averages were obtainable in this investigation; the standard deviations only slightly exceed those of the leafstalk (the average of all standard deviations of the seedlings amounts to 0·25 $\mu$ for the leafstalk and to 0·29 $\mu$ for the bark). On the other hand the variations of the averages of the latex tubes in the bark, taking into consideration their larger diameter, is relatively smaller as compared with the tubes of the leafstalk. It is possible that this or unknown errors in measuring, or both, prejudices the correlation of the bark tubes as compared to the leafstalk tubes.

The correlation coefficients derived from the examined material are all so small that no value can be set upon them. Especially they do not bear comparison with the correlation coefficient 0·75 between yield and number of rings of latex tubes. Since only productive rings have been considered this coefficient should not be directly compared with that of Bobilioff (+0·55 ± 0·05). Besides the difference in the numbers of examined trees is much too large (29 as against 491).

Little as the coefficients of the diameter imply it is still instructive to make a closer study of the tables. It appears from tables VI and VII that the trees with smallest tubes yield poorly and those with the widest tubes yield very well. But this hypothesis is not reversible, since there are many trees with large tubes which yield indifferently or even poorly; they are to be found in the table in the lower left square.

The possibility exists that the correlation is not a proportional one, the data not being arranged along a straight line but in a triangle; in connection with the paucity of data this possibility should be expressed with the necessary reserve. If curves are constructed from the correlation tables the diameter groups form a symmetric curve; the yield groups however form a very symmetric curve with a considerable accumulation at the left side.

It follows from the tables, that there are trees which yield less than might be expected from the diameter of their tubes, whilst on the other hand there are no trees which yield above their diameter. It can be stated therefore, that a small diameter of the tubes limits the yield of rubber, but that a large diameter gives no certainty that the tree will be a good yielder. (Something of the same kind applies, to a lesser degree, to the number of rings of latex tubes; see table VIII).

A large diameter of the latex tubes is an essential condition for, but unfortunately no proof of a high-yieding tree.

## 3. REASONS WHY NO EXACT RELATION BETWEEN THE DIAMETER OF THE LATEX TUBES AND THE YIELDS EXISTS

11. *Network of the latex tubes.*—Actuallly equation (3) applies to straight capillaries; it has been mentioned already therefore that it can be considered only as approximate for the flow of latex. There are however cases where it cannot be considered at all.

In the bark sections of some trees the latex tubes do not run through continuously, but are often interrupted, since many tubes are culs-de-sac. In this bark the latex must be repeatedly pressed through the anastomoses which have a much smaller diameter. Contraselection tree 180 for instance has this kind of bark. It goes without saying that such a tree must be a poor yielder even if the tubes are very wide.

In contrast to clone 180, clone 183 for instance possesses fine straight uninterrupted tubes which guarantee a satisfactory flow of latex. Of course a tree with such tubes fulfils the theoretical requirements much better. Therefore an examination of the bark should always be carried out besides measuring the diameter of the tubes.

It is also possible that the latex flow is not controlled by the average diameter of the tubes, since the flow must be impeded where in the length wider tubes are connected by smaller ones. In this instance the flow would be controlled by the narrow tubes, and the average of the measurements would be much less important than the minimum diameters.

12. *Distribution of the caoutchouc in the latex tubes.*—In some bark sections slightly stained with Sudan it was noted, that the walls of the latex tubes are covered with a dense layer of coagulated caoutchouc, whilst the middle of the cell remained transparent. According to Dr. Heusser staining with Nile blue makes this more clearly visible.

Unfortunately it was not possible to ascertain whether this is only a peculiar coagulation phenomenon, or corresponds to the natural condition of the tube contents. The objections to alcohol as a fixative have already been mentioned; the important problem whether or not a central area with less caoutchouc particles occurs in the tubes, must therefore be left out of discussion. Nevertheless attention should be drawn to the possibility, that a peripheral layer of more concentrated latex exists. In this case a further condition of the law of Poisseuille would not be fulfilled, *i.e.,* that the liquid should be homogeneous. Perhaps the concentration of the latex depends on the thickness of this layer.

13. *The productive power depends on physiological factors.*—Ashplant concludes from his investigation, that the latex yield is only a lesser degree dependent on physiological factors, but is especially controlled by the diameter of the latex tubes. As proof manuring experiments are brought forward, which showed practically no increase in yield. On the other hand there are many successful manuring experiments on certain soils of Sumatra's east coast, which gave a considerable increase in yield. Besides all planters know that trees which are afflicted with disease can suddenly produce twice their normal dry rubber yield and more, though the latex in this instance has a lower concentration.

It cannot be denied therefore that physiological conditions, which influence the yield, exist. This is to be expected, for what is the use of a tree having large tubes if the latex does not flow out on account of an abnormal dilution reaction caused by some physiological influence, or if regeneration does not occur, or the quantity accumulated in the whole system is inadequate to keep up a continuous flow through large tubes, or indeed if the turgor in the bark is insufficient, etc. ?

Certainly no more can flow through a tube than the diameter allows, but rather less. This is the reason then that so many trees appear in the lower left square in the correlation tables (VI, VII, IX, X). The same reasoning also applies to the number of rings of latex tubes. This cannot be concluded from the correlation coefficients, but can only be deduced from the tables. Publication of correlation coefficients without tables is therefore not sufficient. There is also another problem, very important in practice, which is not explained by Ashplant's theory. The diameter of the tubes remaining constant during the whole life of a tree, the increase in yield, controlled above all by the diameter when the tree grows older, should be the same for all trees. However, this is by no means so. There are clones and individual trees which show an increase in yield proportionately to the age, such as the clone 36, the annual increase during 6 years amounting to ± 7 grammes or the tree 8/12/7 (see table IV) with an annual increase of 11·6 grammes on an average. But there are also clones and trees which for unknown reasons decrease (for instance clone 80 and mother-tree 293) or increase, such as the clone 53, which in the third year of tapping suddenly changed from an underestimated to a satisfactory clone. If these differences cannot be explained by remarkable differences in the forming of new rings of latex tubes by the cambium, they must be set down to physiological causes.

It appears from the data, which could be supplemented, that the physiological tendency and condition of a tree should not be left out of consideration when estimating its yield. This tendency is controlled by a complicated reciprocal action of many factors, and is inherited by the offspring. This is proved by the artificial crosses of Heusser. On the other hand the tube bore test is only concerned with a single anatomical characteristic, the predominant influence of which could not be corroborated. For the time being planting good selected seed (from isolated seed gardens) seems more promising than choosing by means of the tube bore from a mixture which besides good yielders also contains physiologically bad yielders.

## CONCLUSIONS FOR PRACTICE

It follows from these investigations, that trees with very narrow tubes can be recognised as poor yielders. Therefore the question immediately arises, whether the tube bore test can come under consideration for the selection of Hevea.

For estate practice it seems impracticable to carry out this work systematically and uneconomic also, since a number of trees with large tubes can be disappointing later on. Besides it has not yet been proved that seedlings have a constant tube bore from the earliest youth onward. It has been shown in this treatise, that 6 months old buddings of proved clones have moderately wide to wide tubes, but as is known seedlings differ from buddings in some respects.

Is it possible to use the diameter test as set forth in this paper for the selection work of the experimental stations, to eliminate as early as the nursery stage, from a given population from one pair of parents the disappointing individuals which always occur ? The objection at once arises that it has not yet been proved that seedlings, before planting in the field, already possess the tube bore characteristic of tappable age. In any case the method seems to have no future, since apparently the selection methods so far practised have already eliminated the trees with narrow tubes. Of the examined crosses (table IV) not one has such narrow tubes that it could be rejected without hesitation, whilst this could have been done with some Kampong trees (table V). Table VI shows that the material (clones and crosses) selected by the usual methods can all be classed in the groups exceeding 16 $\mu$. The classes of 14 and 15 $\mu$ have disappeared for this planting material. Carrying on selection within such a population seems rather hopeless, since the differences become too small.

Unselected plantation seeds would give populations from which the worst yielders could be eliminated according to the diameter test, but at present it is rightly considered antiquated to use such seed as planting material, except for use as buddings-stocks. In the present state of the Hevea selection hardly any benefit can be derived from Ashplant's discovery, following the methods here set forth.

## SUMMARY

From Ashplant's publications 3 hypotheses were inferred. A method for the preparation of the sections has been worked out which guarantees constant results of the measurements. The necessity of giving the standard deviations of each series of measurements must be stressed, since the diameters of the latex tubes vary considerably.

The third hypothesis, the constancy of the diameter of the latex tubes from the 6th month, and the heritability of this could not be checked, since such an investigation would last years.

The second hypothesis, according to which trees with large bore tubes in the bark also possess wide tubes in other parts, could be corroborated to a certain extent. The ratio between the diameter of the bark tubes and that of the leafstalk tubes varies in the examined material from 0·56 to 0·83 with an average of 0·686 ± 0·010. In this connection it should be mentioned that the ratio is more constant in known crosses (table IV, column 4) than in Kampong trees (table V, column 5).

At present the first hypothesis, the relation between the diameter of the latex tubes and the yield in grammes of dry rubber, is the most important for selection in Hevea, since the planters are anxiously awaiting reliable data on this problem. From the data here compiled the following may be concluded :

1. A certain relation, but no satisfactory correlation, exists between the diameter of the latex tubes and yield in grammes of dry rubber.

2. Trees with narrow tubes are poor yielders, but trees with wide latex tubes are by no means always good yielders of rubber. This appears from the correlation tables VI, VII, IX and X, in which many trees are placed in the lower left square.

3. It is true that generally speaking the best yielders of dry rubber have wide tubes, but the converse is not true. Consequently the prediction of the future production exclusively on the diameter of the latex tubes is rather dubious.

4. There are two reasons why trees with large tubes can be poor yielders :

a. The anatomy of the bark does not satisfy the theoretical requirements, as many tubes end blindly instead of running through. Perhaps the narrowest tubes exert more control than the average diameter.

b. Consequent on known or as yet unknown physiological causes the tree does not reach the maximum yield (insufficient accumulation of latex in the whole system, unsatisfactory regeneration, absence of the dilution reaction on tapping, etc.). In this instance an increase of yield by manuring may be expected.

5. In the examined material the correlation between tube bore and yield of rubber is worse than that between number of rings of latex tubes and yield.

6. It appears from the correlation table VIII that something similar to that mentioned (2) and (3) for the diameter of the tubes applies to the number of rings of tubes. The causes given (4) may be brought forward for the explanation of this relation.

7. As regards the trees examined the diameter method is of no more value than counting the rings of tubes. Both methods are handicapped by the same fault, viz. a finely developed system of tubes is not necessarily accompanied by more than normal yield power. The yielding power however is inscrutably hidden in the finer physiology of the Hevea tree.

# RUBBER SEED CAKE AS A FEEDSTUFF*

ALTHOUGH experiments have been conducted for several years in the use of rubber seed for crushing, the seed was not used in this country commercially until 1929, when owing to the world shortage of flax-seed occasioned by the extremely short crops in Argentina and the United States for that year, and the resulting high prices, the Hevea rubber nut or seed was one of the substitute seeds to be brought into some prominence.

The rubber nut of commerce is the seed of the cultivated rubber tree grown on plantations throughout the Netherlands East Indies and British Malaya. Production is estimated at about 50,000 tons annually, of which some 30,000 tons are produced in British Malaya. Sumatra and Java together produce approximately 175,000 tons and the rest is produced in other islands of the Netherlands East Indies.

The trade estimates that 1930 imports will amount to about 3,500 tons, which is expected to be increased to at least 10,000 tons in 1931.

Rubber seed when crushed produces about 44 per cent. of oil, 50 per cent. cake or meal, and there is approximately 6 per cent shrinkage. The oil is said to be used as an edible oil, and in making soap, linoleum, and paint and has practically the same analysis as soybean oil.

The Virginia Polytechnic Institute, in conjunction with the Virginia Agricultural Experiment Station, has recently issued a bulletin on Feeding Hevea Rubber Seed Meal for Milk Production. This bulletin states that Hevea rubber seed meal is a new high protein cattle feeding concentrate in the United States, having a pleasant odour something like coconut meal. They give the following analysis of recent samples of the meal:

| | | |
|---|---|---|
| Moisture | 5·0-6·0 | Per Cent. |
| Oil | 4·4-6·0 | ,, |
| Protein | 30·0-33·8 | ,, |
| Carbohydrates | 40·0-44·0 | ,, |
| Crude fibre | 7·2-12·0 | ,, |
| Ash | 5·6-6·0 | ,, |

Certain experiments were carried on to determine milk production with dairy cows.

Two groups of cows were used with two cows in each group. The basic ration for each cow was 20 pounds of corn silage and 8 pounds of alfalfa hay daily. Group 1 received 5 pounds of Hevea rubber seed meal and group 2 received 5 pounds of linseed meal daily in addition to the basic ration.

When fed Hevea rubber seed meal, the milk production for both groups totalled 1,937·9 pounds against 1,779·4 pounds when fed with linseed meal; while butterfat production for both groups amounted to 73·1 pounds in contrast to 71·4 pounds.

Experiments were also made in feeding to sheep with satisfactory results.

It appears that the production of rubber seed will shortly begin to offer some competition to linseed, soybean, and other oilseeds, as the value of the oil, cake, and meal begin to be recognized generally.

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* By Felix T. Pope, Foodstuffs Division, Department of Commerce, U.S.A., in *The Malayan Tin and Rubber Journal*, Vol. XX, No. 2, January 31, 1931.

# COCONUT CULTIVATION IN BRITISH GUIANA*

THE coconut plant is one which has, in different countries, adapted itself to a wide range of conditions. Among the factors which usually are associated with the best crop returns are: a light, friable soil with an alkaline reaction, and annual rainfall of about 70 inches, good surface and sub-soil drainage, regular superficial cultivation.

In British Guiana, coconuts have been established in heavy clay soils acidic in reaction—with the exception of the moderately extensive sand reefs on the east coast, Demerara, west coast, Berbice, and the Corentyne coast or on the peaty or pegassy soils of the Pomeroon; the mean rainfall of the colony varies from 81 to 103 inches; during the rainy seasons the soils are frequently in a water-logged condition over a considerable period; it is not the custom to practise any cultivation except the clearing of undergrowth twice or three times a year in coconut areas.

It can therefore be deducted that the state of the local coconut industry is not satisfactory; nevertheless, the acreage in 1912 in coconut was double that in 1905; export of coconut products in 1929 was nearly 20 times greater than it was 10 years ago, and extension of the crop continues.

Since the coconut has been and is being planted under conditions that are, in certain instances, patently unsuitable, and since the crop has been proved to be remunerative (a fact which is indicated by the extension which has taken place) it may be of some local value to discuss the chief considerations relative to cultivation under the conditions existing in British Guiana.

## SOILS

Many coconut cultivations have been established on heavy soils neither through ignorance nor from preference, for probably every local planter has been convinced by experience that a light soil is the most suitable type for coconuts. Coconuts are one of the few permanent crops of those tried that do still give monetary profits in British Guiana. There has been the tendency to increase the area in this crop; the available sandy soils, in comparison with clay, are small; it is thus that a considerable area of the latter type, although known to be less suitable, has been and probably will continue to be planted up in coconuts.

The case of British Guiana is not unique, and there are other countries in which this crop has been established on heavy soils; in such cases, coconuts have proved themselves to be notoriously poor yielders, and can only be cultivated profitably if the greatest attention is paid to estate saniation especially drainage. Under local conditions, the last-named operation is not easy, and is usually expensive. If a proprietor desires to cultivate 400 acres, the cost of empoldering this area (a charge over and above that necessary for internal drainage and one not arising in a naturally drained country) is approximately $8,000·00-$9,000·00 The cost per unit of land, is so high that the proprietor can ill-afford to cultivate a part only of his empoldered area; hence, although the sandy soils occurring only as "reefs" between the clay have been prepared and first planted, ventures have also been made on the clays.

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* By H. D. Huggins, D.I.C.T.A., in *The Agricultural Journal of British Guiana*, Vol. III, No. 3, September, 1930.

The practice of establishing coconuts on abandoned cane land in British Guiana has been frequently deplored by previous workers, and with justification. It is not conceivable that high yields can be obtained except by very intensive cultural and manurial operations. Nevertheless, cane lands, abandoned though they be, have been already empoldered and the coconut proprietor is relieved of an initial expenditure, which the above figure ($9,000·00 for 400 acres) indicates would normally be appreciably beyond the means of a small cultivator. This appears to be a possible explanation for the persistence in a practice which has been so frequently condemned.

Albeit, there are instances in which this crop has been established under circumstances (*e.g.*, badly drained clays that are frequently flooded) which must inevitably be a cause of failure. Mention must also be made of the pegassy soils which, as in certain cases in the Pomeroon, have been planted with this crop. Experience has shown that the palms under such conditions are short-lived, and that these soils should be avoided.

In short, the position with reference to the selection of land for cultivation is that planting should be done preferably on the sand reefs, but successful crops may be obtained on the clays when the drainage and general sanitation are thorough enough.

## SELECTION OF SEED NUTS

Selection as done in British Guiana, is usually not of a complicated nature and consists almost solely of obtaining seed nut from fully mature trees which when nuts are being collected for sowing, appear to be good bearers of a suitable type of fruit. Unfortunately, there is frequently less trouble than this taken, and seed nuts may be merely gathered from the piles of nuts accumulated from an ordinary harvest.

Seed selection is one of the features most deserving of attention in local coconut cultivation. As the area of land occupied per tree is comparatively great and as the crop is of a permanent type, it is essential that the best available planting material be procured.

It is possible that the lack of knowledge of the yield of different varieties, of descriptive characters by which they may be identified, and of the degree to which they may be expected to breed true to type may be factors tending to give the planter little encouragement to attempt selection. The writer assisted in some observations (account unpublished) on the rate at which the inflorescence of 25 coconut palms appeared. These observations were carried on over a period of three months and not once did the opening of male and female flowers coincide on the same plant; on the same inflorescence the female flowers opened 3-6 days after the last male had been shed; new spadices opened up two days onwards after the female flowers (which remain receptive for 24-30 hours) of the preceding inflorescence had opened. The indications are therefore that self-pollination must rarely occur, under these conditions, among the "tall" palms which are the type almost entirely cultivated. Hence, it is apparent that trees which look very much alike will differ constitutionally, and seedlings from the same parent tree will vary, to an extent as yet undermined, on account of cross-pollination.

Nevertheless, there is much which has been gained in coconut cultivation by selection and for practical purposes the following is a system which, if followed, may be relied on to give as good results as may be expected when the present lack of data on coconut-yields is taken into consideration.

The parent trees should be mature, not less than 25 years old, and not more than approximately 40; only trees which are growing under ordinary estate conditions should be chosen, as those observed flourishing near to dwellings, compost heaps on the margins of fields, and in advantageous positions with regard to light and drainage, owe much of their apparent vigour to their favourable surroundings.

The ideal condition would be to have a tree-record by means of which the copra yield of each tree could be known, and, by a process of elimination, ascertain which are the best trees on the estate. This cannot be done hurriedly, nor can it be done economically on a large scale, but the field from which the highest returns are obtained should be selected, every tree in a block of suitable size in that field numbered and a record kept of the number of nuts collected from each tree. Three or four pickings of monthly intervals will give indications of the poorest yielding trees which can be eliminated, and the number retained for observation, considerably reduced. The most prolific trees having been discovered, copra is separately prepared from the ripe nuts of each tree and then the weight of the copra produced per nut estimated.

While the above scheme may be good, it is rather too ambitious to be adopted readily in the system of coconut cultivation which is generally practised in this colony; the following general hints, although less comprehensive, may be more favourably considered and so be of more practical utility:

Select seed nuts from a tree which has short interspaces between consecutive leaf scars that are deep and close together as these characters are indications of regular and heavy bearing. A parent tree should be one containing a large number of leaves (these may vary from about 25 to 40); apart from other reasons, since each leaf normally bears a bunch of fruit in its axil, the greater the number of leaves, the greater will be the number of bunches produced.

Select trees bearing a medium sized rather than a large nut in which the percentage of "meat" is large. It is even preferable to select from the size of the nut rather than from the size of the fruit, for, in some types, the husk is so thick that an erroneous estimate may be made of the size of the nut (and so of meat) within. As to the actual shape of the nut, such divergent views are given that it is probably not a character deserving of too great attention.

## NURSERY

This phase of work is of special importance in the local industry, for not only is a nursery used prior to the establishment of a plantation, but the death rate of growing trees is so high that except the cultivated area be very small—the need for replacements necessitates a constant nursery supply.

The system generally adopted here, and which appears to be satisfactory, is to place the selected seed nuts 1 foot × 1 foot apart in the nursery. This is usually situated not far from the main buildings, and, although it might appear that it would be preferable for the nurseries to be closer to the planting sites, the consensus of opinion is that the advantages obtained from easy and constant observations of the young seedlings warrant the continuation of the present custom.

The soil of the nursery should be light and friable, and surface drains about 9-12 inches deep should be dug approximately 8 feet apart in order to give the young plants the necessary drainage. When the weather is dry, light shade (*e.g.*, by means of plaited coconut leaves) or a straw mulch should be supplied to the young plants. Too much shade must, however, be avoided, as otherwise the plants become "leggy" and adapt themselves, with difficulty, to the change in conditions when they are transplanted.

The rainfall in this country is abundant, but is not evenly distributed throughout the year, so that although in some cases seed nuts are merely placed on the surface of the soil of the nursery and light shade placed over them, as is frequently done in localities with high humidity it is usually the custom to cover the seed nuts with soil so that only the top of the nut can be seen above the ground.

It is necessary to make reference to the beetle pest, known as "Cockles" (*Strategus aloeus* L.), which influences the position in which nuts are placed in the nursery. When nuts are "set" in the soil, the usual custom is for them to be placed on their sides in many districts locally, the nuts are invariably "set" upright so that the end with the germ is uppermost. When the latter is done the damage by this pest is said to be more readily detected and control measures more easily applied. A disadvantage when the seed nuts are placed in an erect position, is that the scale leaves tend to harbour fungi and scale insects, and it is generally admitted that, under normal conditions, better results are obtained from planting the nuts on their sides. Nevertheless the ravages of the pest can be severe, often resulting in the complete destruction of the young shoot, and the practical adjustment to conditions persists.

If a nut is examined, it will be observed that there are three sides, and that one is wider than the other two. If planting on the side is practised, the nut should be so placed that the wide segment is uppermost as it is the latter which has the germinating eye. Manure is not generally applied to nurseries locally, nor is the practice considered advisable. The seed is amply supplied with plant food, and manure merely tends to encourage an excessive formation of fibrous roots; also, if organic manures be used, insect pests may be encouraged.

The period during which seedlings should be left in the nursery before transplanting varies. Germination takes place in 3-6 months, and on many plantations the plants are transplanted in 9-12 months. The advantage of planting at such an advanced stage seems to be that selection of the right type of seedling for planting can be made, "leggy" and other undesirable types discarded. There are, however, planters who prefer to transplant at a much earlier age. It is claimed that when the seedings are young (*e.g.*, when the shoot is 12 in.-15 in. high) their roots are less firmly established in the seed bed and so the shock (of transplanting) is not severe; at this stage, as the "meat" has not already all been utilised, the young plant can better withstand unfavourable conditions in the new environment. This latter opinion the writer has heard frequently expressed, especially on the west coast of Berbice, and it is worthy of note that these also have been the conclusions drawn from certain Philippine experiments.

## FIELD CULTURE

The seedlings should not be planted closer than 30 feet × 30 feet apart. When conditions permit, the position of the holes should be lined out before the drains are dug. The most desirable system is to practice diamond-shaped planting, each hole being at the corner of an equilateral triangle whose sides are 30 feet long. In this method, the plants are allowed sufficient leaf and root space and there are fifty-six trees per acre. When square planting is practised there are only 48 plants to the acre. This difference is equivalent to about 400 nuts per acre per annum in favour of the diamond or "quicunx" planting. In very many cases, however, coconuts are planted locally on land that was formerly laid out for canes with drains 30-36 feet apart. Diamond-shaped planting (with a spacing of 30 feet) is therefore impossible as the drains will interfere with the layout unless certain rows are planted very close to the drains and this is inadvisable. Square planting is therefore the general rule in British Guiana.

Drains of different dimensions are made in different localities varying as the conditions may demand, but, in general, drains 3 feet wide at the top graded to 2 feet at the bottom and 2 feet deep seem, normally, to be satisfactory; the average cost of digging such drains is about 12 cents per rod.

Nuts are "set" in the nursery so that transplanting may be done in either or both of the rainy seasons (April-July and November-January), but November to December planting is preferred because the dry season

which follows is a short one and the young seedlings will not be exposed to a too prolonged dry period before the April rains begin.

Usually, a hole is dug of such depth that when the seedling is transferred the nut can be just covered with soil. It would, however, be wiser to have the holes more thoroughly prepared. When the beds have been lined, holes (3 feet square and 2 feet deep are recommended) should be dug. The holes should be left open for some time, preferably for 8-10 weeks, and refilled with surface soil so that when seedlings are put in, the nut is a little below the original level of the field. The plant should be placed in the middle of the hole, the space around the nut filled in and the soil firmly pressed down so that there is no depression in the immediate vicinity of the seedling in which water is likely to stagnate.

This soil should be mixed with farmyard manure but the latter, under existing local conditions, would frequently not be available. Nevertheless, this is a critical period in the life-history of the plant, as, in many cases, the plant has ceased to get nourishment from the reserves in the nut, and, moreover, the severing of young roots and the actual operation of transplanting constitute a check which necessitates the application of a quick-acting fertiliser when the plants are set in the field. A mixture which has been recommended in other countries is:

150 lb. Superphosphate.
150 ,, Nitrate of Soda.
50 ,, Nitrate of Potash.

This should be thoroughly mixed and 2 lb. applied to each hole.

The seedlings having been transplanted, the custom is, in British Guiana, to fork around each plant as soon as it is well established (*i.e.*, about six months after). Intertillage is obtained indirectly, for 3-4 years after planting, by the cultivation of catch crops. Such catch crops are usually not planted and owned by the proprietor, but belong to renters. The system of renting young orchard fields to farmers for the growth of quick-growing crops has evidently been adopted both because of the dues received and of the general cultivation which is necessarily given to the soil. In the case of coconuts, however, the disadvantages which result from the breaking in and disrepair of drains, the depressions in the beds caused by the planting in mounds of such crops as potatoes and yams, and the haphazard cultural operations practised by tenants detract more from the value, which should be obtained from such a system, than may at first appear.

The extent and frequency of the cultivation of fields in which coconuts are established are subjects on which divergent views are held and on which a pronouncement for local conditions should be made with caution. It would appear, however, that what evidence there is indicates that the economic advantages to be gained locally from clean cultivation are questionable. Harrison and Stockdale considered that after about six years, coconuts required little cultivation, but that drainage should be attended to and weeds cut down and used for mulching purposes. Dash was of opinion that, under tropical conditions, clean cultivation and no attention to the vegetable matter content of the soil led to disastrous results and that the most successful tropical orchardists had learned fully to appreciate the value of the organic mulch. There are definite figures given for certain estates in Portuguese East Africa where a yield of 0·5 ton of copra per acre is obtained by plantations which practise intensive cultivation as against a yield of 0·2 ton per acre without much cultivation. Three is a difference of 0·3 ton which is equivalent to a gross profit of $24-$30 per acre. This figure seems low, and would not offer sufficient inducement to the local planter to maintain his fields in a high state of cultivation unless the labour supply on coconut estates were much increased and the cost of cultural operations (possibly by the use of implemental tillage) considerably reduced.

On the other hand, it cannot be contended that the almost complete state of abandonment, in which a large percentage of the coconut cultivations in British Guiana is kept, is satisfactory, and a practice which is likely to be profitable is the more general use of green manure crops between the rows of coconut trees. If a vigorously growing crop such as Black Bengal Beans (*Styzolobium atterimum*) were selected, weed control could be very considerably aided, the soil could be protected from the mechanical beating action of rain and from excessive heat of the sun. At intervals, the green material should be ploughed in and incorporated with the soil in the middle of the beds. This would increase the general fertility of the soil and especially the content of humus. Apart from other considerations, the mechanical effect of the decomposed organic material incorporated would be very desirable especially on heavy impervious soils on which this crop has been in many instances planted. It should be noted that that Bengal Beans have been well established they will re-seed the area and that there should normally be no recurrent costs for sowing.

Reference may be made at this stage to the care of surface drains. All drains should receive attention and where necessary re-conditioned every year. The drains should, however, be freed of all weeds and grass not less than three times per year, and stoppages, caused by the collapsing of the sides by excessive silting, removed.

## YIELDS AND COSTS

Picking is as a rule done at intervals of 10-12 weeks. The pickers should be experienced, as it is essential that they recognize the fully ripe nuts. A good picker can usually distinguish accurately between the ripe and immature nuts simply by their appearance, but when there is any doubt, tapping with the knuckles is resorted to. The ripe nuts when so tapped emit a hollow sound as against a dull less resonant note by the younger nuts.

The local census returns indicate that the average yield per tree per annum is not much more than 15 nuts. Such a low figure is due to the not inconsiderable coconut area that is in absolute and complete abandonment. Many such cultivations were, at their inception, not thoroughly drained and in unsuitable environment (*e.g.*, heavy clays, pegassy) and as they grew older were deprived of all cultural operations. Low returns could therefore be expected, but there are many coconut plantations on which very much more satisfactory figures are obtained. On the west coast of Berbice and on one estate on the Corentyne, the writer is convinced that the yield is frequently more than 70 nuts per tree per annum and there is an appreciable area on which the normal annual yield is about 40 nuts per tree.

The following yields and costs which are based on figures collected on a number of estates in different parts of the colony may prove interesting:

| | |
|---|---|
| Yield per acre of moderately good estate approx. ... ... ... | 2,000 nuts. |
| Average of 5,000-7,000 nuts yield ... | 1 ton of copra. |
| Yield of copra from 1 acre ... ... | 750-800 lb. |
| 180-250 nuts (mixed) give (by existing primitive system of extraction) ... | 1 tin or 4 gals. of oil. |
| Yield of oil from 1 acre ... ... | 40 gallons (1 drum) |
| Cost of picking and transporting to yard per 100 ... ... ... | 16 cents. |
| Cost of picking, transporting and "peeling" of 100 nuts. ... ... ... | 20-26 cents. |
| (Nuts are always "peeled" when they are sold as such and not converted into copra) ... ... ... | |
| Cost of peeling per 100 ... ... | 6-7 cents. |

| | |
|---|---|
| Cost of "digging" meat from shell per 100 (Frequently, however, when copra is being made, the nuts are not "peeled" but the husk and shell are broken with a pickaxe in one action, and then the meat removed. By this method, a saving of 40 cents-60 cents per thousand nuts is effected). | 6 cents. |
| Cost of drying 1 ton of copra ... ... | $5·12 |

*Copra.*—This is the commercial term of the dried meat or kernel of the coconut. Previously, comparatively small quantities of copra were shipped from this Colony, the trade being almost entirely in nuts, but, as the table below indicates, the production of copra has steadily increased.

*Annual Exports of Nuts and Copra.*

| | 1907-26 (average) | 1927 | 1928 | 1929 |
|---|---|---|---|---|
| Nuts (thousands) | 1,623 | 334 | 322 | 638 |
| Copra (cwt.) | 4,745 | 23,266 | 70,017 | 75,187 |

In most cases, nuts are picked, but rarely only fallen nuts are collected. Where the latter is practised the operation should be carried on at regular intervals and as complete a collection as possible made each time, otherwise some of the nuts remain on the ground, begin to germinate and give rise to a poor quality copra which is pale and does not possess the characteristic colour of high grade copra. Where, however, the nuts are picked and the practice is recommended they should be stored for some weeks after being picked, as stored nuts give the best quality copra.

Almost all of the copra which was formely produced was sun-dried, but the erection of small hot air dryers is becomnig increasingly common. One of the essentials in copra making is that the kernels do not become wet after drying has started; if this occurs, the copra will not keep, readily develops moulds and becomes rancid. The dry season is neither sufficiently well marked nor normally so prolonged as to permit sun-drying being otherwise than a most uncertain procedure.

The hot air dryers in use are of very simple design. At one end of the dryer a furnace is situated, from which the hot gases are conducted through the furnace by boiler tubes. The gases from the furnace are not liberated in the chamber, but escape through a chimney at the opposite end of the dryer so that the temperature of the air in the chamber is raised through the heating of the tubes. As the kernels must be dried with hot dry air, it is essential that suitable ventilation in the chamber be supplied. This is done in many cases by placing, through the side of the chamber, a tube which helps to connect the interior of the dryer with the atmosphere. If the advice of an engineer, experienced in copra-drying, were available, the efficiency of these dryers could doubtless be considerably enhanced. Until such time, however, as co-operative movements may make it possible or until the average size of the plantation is greatly increased, the present type of machinery is not likely to lose favour, in such circumstances, simplicity and initial expenditure have much influence.

*Coconut Oil.*—Oil is not made locally from copra. The fresh kernels are removed and grated. Usually, the grater consists of perforated tin placed around a revolving rotary drum which is operated by a low horse power (*e.g.*, 3 h.p.) oil engine. When continuous work is done 200 nuts (*i.e.*, enough to produce one tin or 4 gallons of oil) in 30 minutes is a fair estimate of the rate of grating.

The grated material is then hand-squeezed, a liberal supply of water is added, the mass washed and squeezed again. Approximately 40 gallons of water are used in the washing and squeezing of 200 nuts. The washings are

then settled in drums for about 16 hours. The oil separates, floates on the top, is skimmed off and boiled. The clear oil is strained off and the residue is then subjected to strong pressure, generally by means of a jack-screw.

When the "milk" from 200 nuts is left to stand for 16 hours about 6 gallons of oil and water emulsion are obtained, and this on boiling is reduced to about 4 gallons. Frequently, a small amount of salt is added to the washings as the sodium chloride in solution is said to hasten the settling process. As the oil is a colloid in suspension, it is to be expected that the oil separation would thereby be facilitated.

Little comment is necessary on this method. It is crude, not economical, and the expression of oil is extremely low. A good grade of oil is produced, but the production costs are so high that there is little encouragement to increase the present output.

## DISEASES

As a result of planting on unsuitable land in the first instance and subsequent neglect, large numbers of coconut trees in the Colony are lost from wilt disease (formerly known as "bud rot") a condition primarily brought about by unfavourable environmental conditions, and entirely comparable in cause and effect with the "Bronze Leaf Wilt" of coconuts which has recently been engaging attention in Trinidad. Contributory factors to the occurrence of the disease are insufficient nutrient, supply, water-logging, and poor cultivation in general, the latter resulting in a bad condition of the soil and an overgrowth of weeds, which block the drains and compete with the palms to the disadvantage of the latter.

The disease, as mentioned above, is most usually found upon heavy soils, but occasionally appears on sand reefs. The symptoms exhibited by the palm are a yellowing and later bronzing in colour of the leaves, which eventually die and hang down. The outer (*i.e.*, the oldest) leaves are affected first, and then the other leaves follow in succession, the crown of the tree being the last part to lose its green colour. By the time that half to two-thirds of the leaves have died, however, the heart and bud of the tree become involved in a wet foetid rot, which is very evident if an affected tree be felled and the crown split open longitudinally. The bacteria, etc., causing this rot are secondary factors, and only attack the already wilted and weakened tissues.

As regards other diseases, the Red Ring disease, so serious in parts of Trinidad, has only been reported once in this Colony a somewhat doubtful case and is not a factor affecting the crop. One or two minor leaf diseases are known but these are to be found as a rule only upon palms already weakened by other causes. Another disease, the exact origin of which is uncertain, causes a disfigurement of the outer surface of the nut, but does not affect the contents.

*Insect Pests.*—The four principal insect pests are the Coconut Caterpillar (*Brassolis sophorae*) the Coconut Stem borer (*Castnia daedalus*) the Coconut Beetle or Cockle (*Strategus aloeus* L.) and the Large Locust (*Tropidacris latreille* Perty).

*Coconut Caterpillar.*—The caterpillars destroy the leaves of the palms at times completely defoliating them. They form "nests" by drawing together several of the leaves on the branches; in these nests they live during the day, emerging at night to feed. They also conceal themselves in the "heart" of the tree. Husk, old branches, "bush," etc., harbour the chrysalises.

For the control of the pest it is necessary to remove completely all such branches and nests and to destroy carefully all caterpillars. Also husks, branches, "bush" and other waste material lying on the ground beneath the trees must be collected together and burnt.

*Coconut Stem Borer.*—This pest lays its eggs about the leaf-bases of the coconut palm and shortly after the larva emerges, it bores into the stem about the leaf-bases and there remains until fully grown causing in the meanwhile considerable damage to the tree. An attacked tree, when in the advanced stage, shows a peculiar droop of the leaves, bending considerably as if too heavy. In some instances an attack of this kind causes the tree to cease to bear fruit and often proves fatal.

The method of control employed against this pest is the careful removal of all the lower branches by cutting them off as completely as possible from the tree. The "worms" should then be secured and destroyed.

*Coconut Beetle or Cockle.*—These beetles burrow into the lower stem and rooting system of young coconut palms, and, if not removed, will cause the death of the palm. A sickly appearance of young palms often indicates the presence of the coconut beetle. The large-sized hole made by the entry of these beetles at the base of the palm is easily detected.

This insect can be controlled if dug out, but, when this is done care must be taken not to injure the palm. A better way is to pour a mixture of kerosene and water or naphtholeum and water into the burrow and this causes the beetles to come to the surface where they may be captured and destroyed.

*The large Locust.*—Both the adult and immature forms of this insect feed on the foliage of the coconut palm, the immature forms being particularly destructive. On the appearance of these pests, unless early steps are taken to have them collected and so prevent their egg-laying, would increase abundantly and cause a great deal of damage to this palm.

These insects are controlled by shaking or sweeping them from the foliage and collecting them in convenient receptacles containing kerosene and water, after which they should be buried or burnt.

# EFFECT OF INTERVAL BETWEEN THE MORNING AND EVENING MILKING ON THE QUANTITY AND QUALITY OF MILK*

THE cows at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, are generally milked at 4 a.m. and 3 p.m. throughout the year, thus giving an interval of 11 and 13 hours between the morning and evening, and evening and morning milkings, respectively. Preliminary tests showed that the evening milk was invariably richer though less in quantity as compared with the morning milk. To study the differences more closely, the previous records were studied and an actual experiment was carried out. The results are interesting and deserve some consideration.

*Data Obtained from the Previous Records.*—Figures, both for quantity and quality of milk for Sindi cows, were compiled, for a complete year, *i.e.*, from June 1927 to May 1928, and are given at the end (table I). The perusal of the figures will show that there was more milk in the morning though it was poorer in fat percentage as compared with the evening milk. The figures for the month of March show almost the same fat percentage, both for the morning and evening. This may be attributed to a little change in the intervals of milkings.

*Experimental Procedure.*—To verify the data compiled from the records an experiment with 10 half-bred cows was undertaken. The cows were divided into two groups, A and B, and every care was taken to make both the groups as nearly identical as possible with regard to age, milk yield, and period of lactation. To further reduce the experimental error the same milkman was kept with the same group throughout the period. The experiment was carried out for 14 days allowing two days as a transitory period. The milking was done at 4-15 a.m. and 4-15 p.m. for the equal intervals, while, for the unequal intervals, the milking was done at 4-30 a.m. and 3-30 p.m.

*The Results Obtained from Groups at Equal Intervals.*—To start with group A was milked at equal intervals. The quantity of milk both for the morning and evening was almost the same, *i.e.*, 54·75 lb. in the morning and 54·81 lb. in the evening. The fat percentage was slightly higher in the evening. The total average fat in the morning was 2·262 lb., while in the evening it was 2·329 lb.

After 6 days, when B was changed to equal intervals, it showed practically the same results as obtained from group A. The average milk in the morning and evening was 58·19 lb. and 57·75 lb., with 2·477 lb. and 2·429 lb. of fat respectively.

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* By C. N. Dave, B.Ag. (Bom.), Harbans Singh, I.D.D. (Alld.), D.R. Khera, L.Ag. (Hons.), and Chanda Singh, L.Ag. (Hons.), in *The Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. IV, Part III, October 1930.

Now, taking the average of the two groups, it will be seen from the following table that the milk and fat are almost the same, with a very slight increase in the morning in quantity and with a proportionate increase in fat in the evening :

| | Group A | | Group B | | A + B (average) | |
|---|---|---|---|---|---|---|
| | Milk lb. | Fat lb | Milk lb. | Fat lb. | Milk lb. | Fat lb. |
| Morning | 54·75 | 2·262 | 58·19 | 2·477 | 56·47 | 2·370 |
| Evening | 54·81 | 2·329 | 57·75 | 2·429 | 56·28 | 2·380 |

The results for the equal intervals are given in a detailed form in table II.

*Results Obtained from the Groups at Unequal Intervals.*—To start with, group B was milked at 4-30 in the morning and 3-30 in the evening. The quantity of milk was more in the morning while the fat percentage was higher in the evening milk, though the total fat was less in the evening, due to the difference in the quantity of milk. After six days, group A, which was being milked at equal intervals during the first period, was changed, to unequal intervals. The results obtained from group A corroborate those of group B at unequal intervals.

| | Group A | | Group B | | A + B (average) | |
|---|---|---|---|---|---|---|
| | Milk lb. | Fat lb | Milk lb. | Fat lb. | Milk lb. | Fat lb. |
| Morning | 57·69 | 2·299 | 61·62 | 2·499 | 59·655 | 2·399 |
| Evening | 50·81 | 2·216 | 53·94 | 2·331 | 52·375 | 2·274 |

Table III will show in detail the above results, given in tabular form.

It will be clear from table IV that the total out-turn of both milk and fat remain constant for the whole day, irrespective of the interval between milkings.

*Conclusions.*—1. By keeping equal intervals between the two milkings the total out-turn of milk and fat remain practically the same, although there is a little increase in fat percentage in the evening which may be attributed to the activity of the fat secreting cells during the daytime.

2. The total quantities of milk and fat for the whole day remain almost constant, irrespective of the interval between milkings. This fact is of great importance from a practical point of view.

3. By keeping an unequal interval between the two milkings one can get more milk with the longer interval and richer milk with the shorter interval and can thus arrange the supply of fresh milk and its products according to the local demand.

Table I

*Statement (from office records) showing the difference of quantity and quality between the morning and evening milk of Sindi cows.*

| Month | | Average No. of animals in milk | | Total milk produced lb. | | Average milk produced per head per day lb. | | Number of days observed for fat test | | Average percentage of fat | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A. M. | P. M. | A. M. | P. M. | A. M. | P. M. | A. M. | P. M. | A. M. | P. M. |
| June | 1927 | 28·8 | 28·9 | 3,778·5 | 3,249·0 | 4·36 | 3·75 | 24 | 22 | 4·91 | 5·39 |
| July | 1927 | 25·2 | 25·1 | 3,067·5 | 2,756·5 | 3·91 | 3·53 | 25 | 25 | 5·09 | 5·45 |
| August | 1927 | 43·4 | 42·8 | 7,456·5 | 6,321·0 | 5·53 | 4·76 | 24 | 25 | 5·16 | 5·31 |
| September | 1927 | 42·6 | 41·2 | 6,833·0 | 5,567·5 | 5·34 | 4·50 | 23 | 22 | 4·81 | 5·38 |
| October | 1927 | 40·2 | 40·0 | 6,769·5 | 5,832·0 | 5·43 | 4·70 | 10 | 5 | 4·79 | 5·24 |
| November | 1927 | 41·4 | 41·4 | 6,632·5 | 5,700·0 | 5·33 | 4·60 | 26 | 28 | 4·77 | 5·21 |
| December | 1927 | 44·9 | 44·9 | 7,144·0 | 6,242·0 | 5·13 | 4·48 | 26 | 28 | 4·53 | 5·08 |
| January | 1928 | 43·4 | 43·5 | 6,601·5 | 5,768·5 | 4·90 | 4·27 | 24 | 24 | 4·14 | 4·55 |
| February | 1928 | 42·6 | 42·6 | 5,864·0 | 5,091·5 | 4·70 | 4·19 | 29 | 24 | 4·19 | 4·43 |
| March | 1928 | 41·7 | 41·7 | 6,113·5 | 5,234·5 | 4·72 | 4·05 | 21 | 19 | 4·47 | 4·46 |
| April | 1928 | 41·7 | 41·5 | 7,330·5 | 6,245·5 | 5·85 | 5·01 | 29 | 17 | 4·03 | 4·15 |
| May | 1928 | 37·6 | 37·7 | 6,555·0 | 5,631·0 | 5·62 | 4·81 | Not available | Not available | Not available | Not available |
| Total ... | | 473·5 | 471·3 | 74,166·0 | 63,639·0 | 60·82 | 52·65 | 261 | 239 | 50·89 | 54·65 |
| Average ... | | 39·5 | 39·27 | 6,180·5 | 5,303·25 | 5·07 | 4·39 | 23·73 | 21·73 | 4·63 | 4·97 |

# Table II

*Showing the milk and fat yields of 10 half-bred cows milked at equal intervals.*

| Date | Group A — 5 cows | | | | | | Date | Group B — 5 cows | | | | | | Total of Groups A & B | | | | Average of Groups A & B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morning | | Evening | | Total | | | Morning | | Evening | | Total | | Morning | | Evening | | Morning | | Evening | |
| | Milk | Fat | Milk | at | Milk | Fat | | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat |
| | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. |
| 20th March 1930 | 54 8 | 2·267 | 55 8 | 2·202 | 110 0 | 4·469 | 27th March 1930 | 58 8 | 2·437 | 58 8 | 2·465 | 117 0 | 4·902 | 113 0 | 4·704 | 114 0 | 4·667 | 56 8 | 2·352 | 57 0 | 2·338 |
| 21st March 1930 | 54 0 | 2·342 | 55 0 | 2·360 | 109 0 | 4·702 | 28th March 1930 | 57 8 | 2·348 | 58 0 | 2·462 | 115 8 | 4·810 | 111 8 | 4·690 | 113 0 | 4·822 | 55 12 | 2·345 | 56 8 | 2·411 |
| 22nd March 1930 | 56 0 | 2·246 | 55 8 | 2·339 | 111 8 | 4·585 | 29th March 1930 | 59 8 | 2·547 | 58 8 | 2·408 | 118 0 | 4·955 | 115 8 | 4·793 | 114 0 | 4·747 | 57 12 | 2·397 | 57 0 | 2·374 |
| 23rd March 1930 | 54 8 | 2·175 | 55 0 | 2·369 | 109 8 | 4·544 | 30th March 1930 | 58 8 | 2·442 | 55 8 | 2·337 | 114 0 | 4·779 | 113 0 | 4·617 | 110 8 | 4·706 | 56 8 | 2·309 | 55 4 | 2·353 |
| 24th March 1930 | 57 0 | 2·402 | 53 0 | 2·358 | 110 0 | 4·760 | 31st March 1930 | 56 0 | 2·356 | 58 8 | 2·501 | 114 8 | 4·857 | 113 0 | 4·758 | 111 8 | 4·859 | 56 8 | 2·379 | 55 12 | 2·429 |
| 25th March 1930 | 52 8 | 2·143 | 55 0 | 2·350 | 107 8 | 4·493 | 1st April 1930 | 59 0 | 2·732 | 57 8 | 2·400 | 116 8 | 5·132 | 111 8 | 4·875 | 112 8 | 4·750 | 55 12 | 2·438 | 56 4 | 2·375 |
| Total | 328 8 | 13·575 | 329 0 | 13·978 | 657 8 | 27·553 | Total | 349 0 | 14·862 | 346 8 | 14·573 | 695 8 | 29·435 | 677 8 | 28·437 | 675 8 | 28·551 | 338 12 | 14·220 | 337 12 | 14·280 |
| Average | 54 12 | 2·262 | 54 13 | 2·329 | 109 9 | 4·592 | Average | 58 3 | 2·477 | 57 12 | 2·429 | 115 15 | 4·906 | 112 15 | 4·739 | 112 9 | 4·758 | 56 8 | 2·370 | 56 4 | 2·380 |

## Table III

*Showing the milk and fat yields of 10 half-bred cows milked at unequal intervals.*

| Date | Group A — 5 cows | | | | | | Date | Group B — 5 cows | | | | | | Total of Groups A & B | | | | Average of Groups A & B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morning | | Evening | | Total | | | Morning | | Evening | | Total | | Morning | | Evening | | Morning | | Evening | |
| | Milk | Fat | Milk | Fat | Milk | Fat | | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat |
| | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | lb. |
| 27th March 1930 | 59 4 | 2·319 | 51 8 | 2·217 | 110 12 | 4·536 | 20th March 1930 | 63 0 | 2·657 | 53 4 | 2·240 | 116 4 | 4·897 | 122 4 | 4·976 | 104 12 | 4·457 | 61 2 | 2·488 | 52 6 | 2·229 |
| 28th March 1930 | 57 8 | 2·243 | 51 0 | 2·228 | 108 8 | 4·471 | 21st March 1930 | 62 8 | 2·368 | 55 0 | 2·423 | 117 8 | 4·791 | 120 0 | 4·611 | 106 0 | 4·651 | 60 0 | 2·306 | 53 0 | 2·326 |
| 29th March 1930 | 59 4 | 2·350 | 53 8 | 2·365 | 112 12 | 4·715 | 22nd March 1930 | 62 8 | 2·583 | 54 8 | 2·305 | 117 0 | 4·888 | 121 12 | 4·933 | 108 0 | 4·670 | 60 14 | 2·467 | 54 0 | 2·335 |
| 30th March 1930 | 57 8 | 2·405 | 49 12 | 2·188 | 107 4 | 4·593 | 23rd March 1930 | 60 8 | 2·507 | 51 0 | 2·088 | 111 8 | 4·595 | 118 0 | 4·912 | 100 12 | 4·276 | 59 0 | 2·456 | 50 6 | 2·138 |
| 31st March 1930 | 56 8 | 2·296 | 51 0 | 2·247 | 107 8 | 4·543 | 24th March 1930 | 61 0 | 2·434 | 54 0 | 2·498 | 115 0 | 4·932 | 117 8 | 4·730 | 105 0 | 4·745 | 58 12 | 2·365 | 52 8 | 2·373 |
| 1st April 1930 | 56 0 | 2·179 | 48 4 | 2·052 | 104 4 | 4·231 | 25th March 1930 | 60 4 | 2·449 | 56 0 | 2·433 | 116 4 | 4·882 | 116 4 | 4·628 | 104 4 | 4·485 | 58 2 | 2·314 | 52 2 | 2·243 |
| Total | 346 0 | 13·792 | 305 0 | 13·297 | 651 0 | 27·089 | Total | 369 12 | 14·998 | 323 12 | 13·987 | 693 8 | 8·985 | 715 12 | 28·790 | 628 12 | 27·284 | 357 14 | 14·396 | 314 6 | 13·644 |
| Average | 57 11 | 2·299 | 50 13 | 2·216 | 108 8 | 4·515 | Average | 61 10 | 2·499 | 53 15 | 2·331 | 115 9 | 4·831 | 119 5 | 4·797 | 104 12 | 4·547 | 59 10 | 2·399 | 52 6 | 2·274 |

## Table IV

*Showing the total daily yields of milk and fat from 10 half-bred cows of equal and unequal intervals.*

| Group A — 5 cows | | | | | | Group B — 5 cows | | | | | | Total of Groups A & B per day | | | | Average of Groups A & B per day | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Equal Interval | | | Unequal Interval | | | Equal Interval | | | Unequal Interval | | | Equal Interval | | Unequal Interval | | Equal Interval | | Unequal Interval | |
| Date | Milk | Fat | Date | Milk | Fat | Date | Milk | Fat | Date | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat | Milk | Fat |
| | lb. oz. | lb. | | lb. oz. | lb. | | lb. oz. | lb. | | lb. oz. | lb. | lb. oz. | lb. | lb. oz. | tb. | b. oz. | lb. oz. | lb. oz. | lb. |
| 20th March, 1930 | 110 0 | 4·469 | 27th March, 1930 | 110 12 | 4·536 | 27th March, 1930 | 117 0 | 4·902 | 20th March, 1930 | 116 4 | 4·897 | 227 0 | 9·371 | 227 0 | 9·433 | 113 8 | 4·686 | 113 8 | 4·717 |
| 21st March, 1930 | 109 0 | 4·702 | 28th March, 1930 | 108 8 | 4·471 | 28th March, 1930 | 115 8 | 4·810 | 21st March, 1930 | 117 8 | 4·791 | 224 8 | 9·512 | 226 0 | 9·262 | 112 4 | 4·756 | 113 0 | 4·631 |
| 22nd March, 1930 | 111 8 | 4·585 | 29th March, 1930 | 112 12 | 4·715 | 29th March, 1930 | 118 0 | 4·955 | 22nd March, 1930 | 117 0 | 4·888 | 229 8 | 9·540 | 229 12 | 9·603 | 114 12 | 4·770 | 114 14 | 4·802 |
| 23rd March, 1930 | 109 8 | 4·544 | 30th March, 1930 | 107 4 | 4·593 | 30th March, 1930 | 114 0 | 4·779 | 23rd March, 1930 | 111 8 | 4·595 | 223 8 | 9·323 | 218 12 | 9·188 | 111 12 | 4·662 | 109 6 | 4·594 |
| 24th March, 1930 | 110 0 | 4·760 | 31st March, 1930 | 107 8 | 4·543 | 31st March, 1930 | 114 8 | 4·857 | 24th March, 1930 | 115 0 | 4·932 | 224 8 | 9·617 | 222 8 | 9·475 | 112 4 | 4·809 | 111 4 | 4·738 |
| 25th March, 1930 | 107 8 | 4·493 | 1st April, 1930 | 104 4 | 4·231 | 1st April, 1930 | 116 8 | 51·32 | 25th March, 1930 | 116 4 | 4·882 | 224 0 | 9·625 | 220 8 | 9·113 | 112 0 | 4·813 | 110 4 | 4·557 |
| Total | 657 8 | 27·553 | Total | 651 0 | 27·089 | Total | 695 8 | 29·435 | Total | 693 8 | 28·985 | 1353 0 | 56·988 | 1344 8 | 56·074 | 676 8 | 28·496 | 672 4 | 28·039 |
| Average | 109 8 | 4·592 | Average | 108 8 | 4·515 | Average | 115 15 | 4·906 | Average | 115 9 | 4·831 | 225 8 | 9·498 | 224 1 | 9·346 | 112 12 | 4·749 | 112 1 | 4·673 |

# NOTES OF INTEREST

## TEA GROWING IN NYASALAND

MR. F. A. Stockdale, Agricultural Adviser to the Secretary of State for the Colonies, said while recently in Nyasaland that he favoured the establishment of a small agricultural research station in Mlanje, for the purpose of investigating soils and the methods of tea cultivation, especially shade and pruning. Cultural conditions in that district struck him as approximating more closely to those obtaining in parts of Assam than in Ceylon; he commented on the general absence of shade trees. Mr. A. E. Shinn, the well-known local planter, said that there are now about 8,000 acres under tea in Mlanje and a further 2,000 in Cholo.—*East Africa,* Vol. 7, No. 331, January 22, 1931.

## TEA

THE tea shrub is *Camellia Thea* Link., a native of Upper Assam, Cachar and China, and cultivated in other parts of the world. The first mention of tea is in a Chinese annal dated A.D. 793. Europeans do not appear to have acquired any knowledge of tea until the latter half of the sixteenth century. Russia first obtained tea in 1638, through the envoy to the Mongol Emperor, who received several packets overland as a tribute to the Czar. This soon found favour with the Court of Moscow and became a national beverage. It was also conveyed to Europe by the Dutch East India Company and was probably introduced into England through the Portuguese before the year 1657. The English East India Company took steps to secure regular supplies, as in 1677 tea was an expensive luxury, being sold in London for £5 to £10 a pound. During the eighteenth century tea was imported from China in increasing quantities under the control of the East India Company. For the 100 years 1710-1810 the aggregate sales amounted to 750,470,016 ob., the value of which was close on £130,000,000. Difficulties having arisen with China, the British Government became interested in an effort to produce tea in India. Lord William Bentinck, encouraged by the experiments of Bruce and Scott in Assam, took up the matter of local cultivation. The first Assam tea was sent to England in 1838. In 1852 the tea industry appeared so promising that in a few years the whole of the upper portion of the Province of Assam was converted into tea plantations, and followed soon afterwards by the opening up of estates in Chittagong, Chota Nagpur and the Duars. Tea now occupies half a million acres of land in Assam, and the industry gives lucrative employment to 600,000 persons. The first exports in 1838 were 488 lb., in 1904 they stood at 200 million, valued at £6,000,000. The production of tea in the whole of India in 1924 was 375, in 1925, 364, and in 1926, 392 million pounds. Assam contributed 62 per cent., North India (excluding Assam) 25 per cent., and South India 13 per cent. More than 84 per cent. is shipped to the United Kingdom. India and Ceylon are therefore giving to England a regular supply of a much purer and an infinitely cheaper article than it formerly received from China.—*The Chemist and Druggist,* Vol. CXIV, No. 2659, January 24, 1931.

## TUNG OIL PRODUCTION IN FLORIDA

A NEW industry has lately sprung up in Florida, United States, namely, the growing of Tung trees for oil, for which the climate is excellently adapted. The Tung tree (*Aleurites Fordii*) is normally found growing wild on hillsides and rough slopes, without cultivation or attention. Experience in Florida has shown that the tree will grow successfully on any type of soil that is well-drained, free from limestone, and possessing a slightly acid reaction. The tap-root penetrates to a depth of six or seven feet and it is important that the level of the underlying water table be below that depth. The trees will not succeed on wet land. Large areas of high Pine lands in central Florida are found to be ideally adapted to the production of Tung oil, and extensive tracts of that type will undoubtedly, within the next few years, be planted with Tung trees. Tung trees were introduced into Florida from China about twenty years ago. The Chinese employ the oil in waterproofing their clothes, boots, junks and residences. The American industrial chemist has expanded the utility of Tung oil in more than a hundred every-day uses. In the manufacture of paints and varnishes it has been found far superior to Linseed oil; it has extended to the peparation of enamels and lacquers, metal and cement dressings, insulating compounds, auto-brake linings, oilcloth, linoleums, and even dress materials, which latter are composed in beautiful texture and patterns from a combination of cellular material and Tung oil. So far, there are only a few thousands acres of Tung trees in Florida, but it is anticipated that about 10,000 acres will shortly be planted and as it is estimated that 400,000 to 500,000 acres in bearing will be necessary to supply the present demand, it is evident that the question of overplanting need not concern the grower for another decade.—*The Gardeners' Chronicle,* Vol. 89, No. 2300, January 24, 1931.

## INTERESTING RUBBER FIGURES

IT is not generally known that the pre-war consumption of raw rubber was greater in Europe than in the U.S.A.

The figures are illuminating, because immediately the war broke out America began to go ahead for perfectly obvious reasons. The following are the figures for the 4 years pre-war in tons:

| | United States | Europe |
|---|---|---|
| 1910 | 42,254 | 54,857 |
| 1911 | 41,901 | 54,026 |
| 1912 | 55,979 | 60,916 |
| 1913 | 52,028 | 73,522 |

It will be seen that Europe was going ahead very fast and, no doubt, would have continued to do so only for the Great War. However, everything now points to the balance of the rubber trade gradually swinging in Europe's favour again.

Last year America imported 528,608 tons of raw rubber as against 296,773 tons for Europe, which, of course, includes the United Kingdom.

The population of Europe is capable of consuming much greater quantities than it is now doing and everything points to progressive increase in consumption from this quarter for many years to come.

Another interesting point is that "other countries" than those mentioned, which in 1930 took only 1,980 tons of rubber, imported 51,757 tons in 1929.

Most of this increase is attributable to Japan, which country is fast becoming an important factor in the rubber goods manufacturing world. She has a vast potential market at her doors and should be given every encouragement to develop this market.—*The Malayan Tin and Rubber Journal,* Vol. XX, No. 2, January 31, 1931.

# MEETINGS, CONFERENCES, ETC.

## RUBBER RESEARCH SCHEME (CEYLON)

**Draft Minutes of a meeting of the Board of Management, held at the Grand Oriental Hotel, Colombo, on Friday, December 5, 1930, at 9 a.m.**

**Present.**—The Hon'ble Dr. W. Youngman, Director of Agriculture, (in the chair), the Assistant Colonial Treasurer, Messrs. A. S. Collett, A. E. de Silva, B. F. de Silva, C. E. A. Dias, J. Farley Elford, the Hon'ble Mr. C. H. Z. Fernando, the Hon'ble Mr. H. R. Freeman, the Hon'ble Mr. C. E. Hawes, Messrs. J. D. Hoare, J. A. D. Finch Noyes, C. A. Perera, D. C. Senanayake, Colonel T. Y. Wright, Mr. J. I. Gnanamuttu, (*Secretary*).

Apologies for absence were received from Mr. F. H. Griffith and the Hon'ble Mr. A. F. Molamure.

Mr. T. E. H. O'Brien, Chief Technical Officer, was present by invitation.

### 1. CONSTITUTION OF NEW BOARD OF MANAGEMENT

The Chairman stated that the nominations to the Board of Management of the gentlemen named below had been published in a Government *communiqué,* and he was glad that their first meeting was so well attended:

The Director of Agriculture (*Chairman*)
The Assistant Colonial Treasurer

Unofficial Members of the Legisiative Council, nominated by His Excellency the Governor:

The Hon'ble Mr. C. E. Hawes
The Hon'ble Mr. H. R. Freeman
The Hon'ble Mr. A. F. Molamure

Nominated by the Ceylon Estates Proprietary Association:

Colonel T. Y. Wright
Mr. J. A. D. Finch Noyes

Nominated by the Planters' Association of Ceylon:

Mr. J. Farley Elford
Mr. F. H. Griffith

Nominated by the Rubber Growers' Association (Incorporated):

Mr. A. S. Collett
Mr. J. D. Hoare

Nominated by the Low-country Products Association:

The Hon'ble Mr. C. H. Z. Fernando
Mr. C. E. A. Dias
Mr. D. C. Senanayake
Mr. A. E. de Silva

Nominated by His Excellency the Governor to represent small-holders:

Mr. C. A. Perera
Mr. B. F. de Silva

### 2. MINUTES

(a). The minutes of the final meeting of the Executive Committee of the old Rubber Research Scheme had been circulated to the members of the new Board.

(b). The Chairman stated that he was given discretion, in respect of the minutes of meetings of the Board of Management of the Coconut Research Scheme, to omit or vary the official record before their publication in the Press, but of course the full minutes of proceedings would be available to members of the Board. Mr. Finch Noyes moved, and Colonel Wright seconded, that the Chairman be authorised to follow the same procedure as that of the Coconut Research Scheme. Mr. Dias enquired whether members were not at liberty to consult the Associations which they represented. Mr. Bickmore pointed out that certain questions might arise which it would not be desirable to discuss outside the Board and that accredited representatives of Associations should be trusted to take responsibility for their action. Mr. Finch Noyes said that, in his own case, he consulted his Association in regard to particular points on the agenda. Colonel Wright added that a *résumé* of the proceedings of Board meetings was expected by the Associations from their representatives. It was generally agreed that a hard and fast rule about consultation with Associations could not be laid down. Colonel Wright suggested that confidential records might be entered and circulated as such on a separate sheet of minutes. It was finally decided that an expression of opinion should be recorded at each meeting what, if any, matter should be kept confidential. It was also agreed that publication of the minutes in the Press be made within two weeks of a meeting.

## 3. CONTINUANCE OF THE WORK AND STAFF IN LONDON

(a). With reference to the correspondence and memoranda which had been circulated to the members, the Chairman submitted that an abrupt termination of the work in London would be detrimental to the industry and recommended that the London organization should be continued. Mr. Bickmore added that the usefulness of the work in London had been acknowledged by the technical staff. In reply to Mr. Dias, Mr. O'Brien stated that the rubber industry of Java had an organization in Holland. The Chairman was of opinion that in the past Ceylon had had a return for the money expended in London. In reply to a query whether it was not possible to confine the work to Ceylon, the Chairman pointed out that it was necessary to have an organization where their market was. Mr. Bickmore added that Ceylon should have a body to whom technical problems could be referred and by whom the requirements of manufacturers could be studied. It was understood that the reason why Malaya had not done any work in London up to now was that their institution started only three years ago.

Mr. Freeman moved that the London staff and research work be continued on the present footing for 1931. This was seconded by Mr. Dias, supported by Mr. Hoare, and carried unanimously.

(b). The scheme of amalgamation of the research work in London with that of Malaya, as set forth in the London Secretary's letter of 7th July, 1930, which had been circulated to members, was deferred for further consideration, the Chairman pointing out that the London Advisory Committee was submitting some points for consideration. Mr. Dias submitted that the proportion of 30% (£1,500) of the estimated initial annual expenditure of £5,000, which had been suggested for Ceylon, called for comment in view of the fact that the ratio of exports of rubber from Ceylon and Malaya was 18 to 82 and that of the acreage was 20 to 80.

## 4. TRANSFER OF ASSETS, LIABILITIES AND STAFF OF THE OLD SCHEME

The Chairman mentioned that the Executive Committee at their last meeting had discussed the question of handing over to the new Board and had resolved unanimously that the entire assets, liabilities and staff of the old Rubber Research Scheme be offered to the Board of Management of the new Rubber Research Scheme, with effect from August 1, 1930, the date on

which the Rubber Research Ordinance came into operation. This offer was subject to confirmation by a meeting of subscribers to the erstwhile Scheme. Mr. Bickmore stressed the advisability of taking over the capital of the Scheme and building upon it; the alternative to taking over would be to disband all work and staff for at least one year. The Chairman added that the cash balance of the old Committee would be exhausted by the end of December. The assets consisted of land acquired, buildings, water supply, laboratory apparatus, furniture, fittings and office equipment, the London plant, and investment on the Experiment Station, Nivitigalkele, making a total roughly of Rs. 137,000. The question of leases that the old Committee had entered into would have to receive attention.

Mr. Freeman moved that the assets, liabilities and staff of the old Rubber Research Scheme be taken over by the Board of Management. Colonel Wright seconded. This was carried unanimously.

(b). The Cairman stated that the Colonial Auditor would audit the accounts as from August 1, 1930. It was decided that no action was called for in regard to audit fee.

The Chairman regretted that he had to attend a meeting of the Finance Committee of the Legislative Council with regard to a matter that could not be postponed, at 10 a.m., and suggested that Mr. Bickmore be acting Chairman during his absence. This was proposed by Mr. Finch Noyes and seconded by Mr. Collett. Mr. Bickmore took the chair.

## 5. CHEMIST AND CHIEF TECHNICAL OFFICER

A decision as to the terms of re-engagement of Mr. T. E. H. O'Brien was thought desirable before the draft estimates for 1931 were taken up. It was proposed by Mr. Dias, seconded by Mr. Senanayake, and carried unanimously, that Mr. O'Brien's services should be retained on terms which would be no worse than under his present agreement, with the continuance of the allowance paid to him as Chief Technical Officer. Mr. O'Brien was then asked as to his intentions about home leave. Mr. O'Brien thought it would not be in the interests of the Research Scheme that he should take leave before further staff had been appointed. He wished to do what was best for the Scheme and would be willing to postpone his leave. The terms offered for the continuance of Mr. O'Brien's services were explained to him and accepted.

## 6. DRAFT ESTIMATES OF INCOME AND EXPENDITURE FOR 1931

### *Rubber Restriction Fund*

The acting Chairman explained that alternative estimates had been circulated on the footing: (a) of the Cess collections only accruing as revenue, and omitting provision for work in London, and (b) of the Rubber Restriction Fund being made available and a full programme of work being undertaken. He was of opinion that the Rubber Restriction Fund should be regarded as a capital sum available for the purchase of an estate or the development of an estate from jungle. He added that the sum of Rs. 100,000 reserved out of the Restriction Fund was against the possibility of restriction being reintroduced and that the entire fund might be released, if need be under an amending ordinance. It was necessary to decide whether the Board should ask Government for any part of the Rubber Restriction Fund for the purposes of the rubber industry. Mr. Dias' view was accepted that the surplus money in the Rubber Restriction Fund should be utilised only for capital expenditure and that application for this money should not be made until a scheme of capital expenditure was drawn up. Mr. Finch Noyes proposed, Mr. Collett seconded, and it was carried unanimously, that the Rubber Restriction Fund be not taken into consideration in framing the estimates for 1931.

## *Income*

The acting Chairman thought that the estimate of Rs. 120,000 under Cess collections was too conservative. Mr. Collett suggested that a revenue of Rs. 150,000, based on exports approximating 70 per cent. of those of the current year, would be reasonable. It was agreed that Rs. 150,000 should be substituted for Rs. 120,000. Mr. Collett further suggested that the sum of Rs. 100,000 accruing (for the five months) up to December 1930 be reserved as a working capital. This was agreed to.

## *Personal Emoluments*

Mr. Dias urged that the point should be decided whether future salaries to the superior staff should be paid on a sterling or a rupee scale. Mr. Senanayake proposed that a rupee scale should be adopted. The acting Chairman suggested that the adoption of a rupee scale should await a similar course in the public services generally. It was decided that the matter should receive consideration in 1931.

Dr. Youngman resumed the chair at 10-45 a.m.

*Item No. 1. Director of Research.*—With reference to the scale of pay for a Director of Research, the Chairman mentioned that the Rubber Research Institute of Malaya advertised in July last for a Director at a salary of £2,520-£140-£2,800 per annum. He suggested that it would be wisdom to employ the best possible man they could obtain and be prepared to pay a salary commensurate with his reputation and qualifications. The London Advisory Committee, he said, were willing to help in making appointments. Mr. Dias thought they should not hesitate to advertise their requirements in Java and America as well as elsewhere. Mr. Freeman suggested that the post should be made well-known and that all applications should come before the Scheme in the first case so that the Scheme could see who was available.

Mr. Dias proposed and Mr. B. F. de Silva seconded that the Chairman be authorised to advertise with a view to securing the best man available and that the salary be left open. This was agreed to, and the salary of Rs. 18,000 included in the draft estimates was passed as a provisional vote.

*Item No. 3. Physiological Botanist.*—It was decided that the provision of Rs. 4,500 for salary for six months should remain, but that a selection for the post be made after the appointment of the Director of Research.

*Item No. 5. Geneticist.*—Mr. Dias urged the need for the immediate appointment of a Geneticist. The Chairman explained that the type of man required both for this post and that of Physiological Botanist might in a way depend upon the future Director. If the Director, for instance, were a Geneticist his advice would be of value in connection with the matter.

After further discussion, Mr. Finch Noyes moved that the posts of Director of Research, Physiological Botanist and Geneticist be all advertised and that applicants be invited to state the salary required. This procedure was approved. Mr. B. F. de Silva suggested that the applications should be addressed to the Chairman of the Board and that any further steps to be taken be considered by the Board after the receipt of the applications. This view was supported by Mr. Dias and was accepted. It was desired that the Chairman might consult Dr. P. J. S. Cramer, formerly Director of the Experimental Station, Buitenzorg, Java, who was at the time in Colombo, upon the subject of securing a Director of Research.

*Item No. 17. Bonus to Subordinate Staff.*—It was decided to delete the provision of Rs. 458 from the 1931 estimates in view of the financial depression. The payment of the usual bonus for the current year was sanctioned.

*Item No. 9. Budding Instructor.*—Mr. Dias urged the necessity of having a really good expert man for budding work at the Experimental Station. Such a man, he said, should be able to show 80% successes in budding. The provision of Rs. 720 was increased to Rs. 840, the commencing salary of an Agricultural Instructor (probationer's grade.)

The total sum voted under the head Personal Emoluments amounted to Rs. 67,673.

## *Other Charges*

Mr. Dias suggested that a scheme of development should be determined that day. The Chairman said that, necessary as he thought it was actively to embark upon a policy of development, he also thought there was great wisdom in first appointing a Director of Research. This view was supported by Mr. Finch Noyes and was endorsed by the Board.

*Item No. 22. Travelling.*—The Board approved of the payment of an inclusive motor car mileage of 25 cents for attendance at meetings, after the practice of the Coconut Research Scheme.

## *Special Expenditure*

*Item No. 24. London Advisory Committee Expenditure.*—The London Advisory Committee's application for £2,605 to meet their normal expenditure in 1931 was accepted and this item was included in the estimates.

*Item No. 25. Sinking Fund for Bonuses and Passages.*—At Mr. Bickmore's suggestion the provision under Bonus and Passage Fund was increased from Rs. 6,300 to Rs. 10,000.

*Item No. 23. Experiment Station.*—Mr. Dias enquired whether the rubber research work at Iriyagama was to be continued by the Department of Agriculture or handed over to the Rubber Research Scheme. The Chairman replied that the experiments in hand would be continued and completed by the Department in 1933. He added, in reply to Mr. Freeman, that Government had been anxious to make a start at a time when the future of the Rubber Research Scheme was in a nebulous state. The lines of work proposed in connection with seed gardens and budwood nurseries remained to be undertaken and the Board might consider taking over this part of the programme under the Rubber Restriction Fund, after the arrival of the new staff.

The total sum voted under the head Other Charges, including Special Charges, amounted to Rs. 87,217.

## 6. STAFF

The Chairman invited consideration of an applictaion from a laboratory assistant for the payment of fees for medical attendance on his wife. Mr. Finch Noyes stated that on the estates every such case was considered on its merits. It was decided that the present case did not appear to call for special consideration and could not be entertained.

## 7. EXPERIMENT STATION

(a). *Drainage of Budwood Nursery.*—After discussion, the Board considered it inadvisable to proceed at present with the suggested scheme of drainage.

(b). The Chairman suggested that a scheme of manurial experiments submitted by Mr. Taylor and some correspondence thereupon might not be pursued for the present. This was approved.

(c). Mr. Farley Elford proposed and Mr. Senanayake seconded that a Visiting Agent be not employed. At the instance of Mr. Dias, it was agreed that, should the position of a Director of Research remain long in abeyance, this might be again considered at a later date.

(d). The Chairman referred to a letter from Mr. Dias calling for information relating to the work at Nivitigalkele. A written statement prepared by Mr. O'Brien and supplying the information so far as possible was tabled. It was considered desirable that similar information required by any member of the Board should be supplied by the research staff at the discretion of the Chairman; any matter of a confidential nature to be stamped as confidential and treated as such.

## 8. TECHNICAL REPORTS

The progress reports of the Chemist, the Mycologist and the Agricultural Assistant for October 1930, copies of which had been circulated, were passed without comments.

Mr. Bickmore raised the question of appointing a Technical Committee to come to decisions upon technical matters. The Chairman suggested that such a Committee had not proved altogether suitable in the past and that the Director of Research or the Chief Technical Officer could always receive advice upon any point from the scientific staff at Peradeniya. Mr. Dias supported this method rather than the appointment of a Technical Committee, and it was accepted by the Board as the best course to adopt.

## 9. PUBLICATIONS

(a). The publication of Mr. Murray's booklet on Diseases of Rubber, in the same way as the booklets prepared by Messrs. O'Brien and Taylor, was sanctioned.

(b). Correspondence with the Rubber Growers' Association and the Rubber Research Institute of Malaya regarding exchange of publications was considered. The matter was left over for further consideration after the Rubber Growers' Association had stated the minimum number of copies they required of the bulletins, leaflets and circulars of the Scheme.

(c). The question as to what persons were eligible for the free supply of the Scheme's publications was also noted for further consideration. Mr. Bickmore urged the necessity of circulating the results of all research work.

(d). With reference to the London Advisory Committee's minutes of October 24, 1930, and their complaint that they had not sufficient information of activities in Ceylon, the Chairman thought that *The Tropical Agriculturist* should be subscribed for by the people in London who were interested in Ceylon. With reference to their suggestion that the decision not to reprint Mr. L. Lord's report upon his visit to Java, Sumatra and Malaya, be reconsidered, the Chairman was authorised to order a reprint if and to such extent as the balance of funds of the old Rubber Research Scheme could meet the cost.

## 10. FUTURE MEETINGS

It was resolved that a meeting of the Board should be held every other month and that the third Thursday of the month should be adhered to as far as possible. It was agreed that notices of motions be sent to the Secretary fifteen days before the date of a meeting. Mr. Freeman desired that a further effort should be made to obtain a Committee room of the Legislative Council for the meetings of the Board.

By order,
JOS. I. GNANAMUTTU,
Secretary,
Board of Management,
Rubber Research Scheme, (Ceylon).

Peradeniya, 8th December, 1930.

# ANIMAL DISEASE RETURN FOR THE MONTH ENDED 28th FEBRUARY, 1931

| Province, &c. | Disease | No. of Cases up to Date since Jan. 1st 1931 | Fresh Cases | Recoveries | Deaths | Balance Ill | No. Shot |
|---|---|---|---|---|---|---|---|
| Western | Rinderpest | 107 | 60 | 19 | 74 | 12 | 2 |
| | Foot-and-mouth disease | 49 | 29 | 24 | ... | 25 | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Rabies (Dogs). | 2* | 1 | ... | ... | ... | 2 |
| | Piroplasmosis | ... | ... | ... | ... | ... | ... |
| Colombo Municipality | Rinderpest | .. | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 148 | 92 | 79 | 4 | 65 | ... |
| | Anthrax | 7* | 6 | ... | 7 | ... | ... |
| | Rabies | 2 | 2 | ... | 2 | ... | ... |
| | Haemorrhagic Septicaemia | ... | ... | ... | ... | ... | ... |
| | Black Quarter | ... | ... | ... | ... | ... | ... |
| | Bovine Tuberculosis | ... | ... | ... | ... | ... | |
| Cattle Quarantine Station | Rinderpest | .. | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | ... | .. | ... | ... | ... | ... |
| | Anthrax (Sheep and Goats) | 54 | ... 30 | ... | 54 | ... | ... |
| Central | Rinderpest | ... | .. | ... | ... | ... | ... |
| | Foot-and-mouth disease | 14 | 14 | ... | ... | 14 | ... |
| | Anthrax (Sheep and Goats) | | | | | | |
| | Rabies (Dogs) | 6 | 6 | ... | 6 | ... | ... |
| Southern | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 567 | 424 | 430 | 2 | 135 | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Rabies (Dogs) | ... | ... | ... | ... | ... | |
| Northern | Rinderpest<br>Foot-and-mouth disease<br>Anthrax<br>Black Quarter<br>Rabies (Dogs) | FREE | | | | | |
| Eastern | Rinderpest<br>Foot-and-mouth disease<br>Anthrax | FREE | | | | | |
| North-Western | Rinderpest | 2212 | 1097 | 61 | 1883 | 17 | 251 |
| | Foot-and-mouth disease | ... | ... | ... | ... | .. | ... |
| | Anthrax | ... | ... | ... | .. | ... | ... |
| | Pleuro-Pneumonia (in Goats) | ... | ... | ... | ... | ... | ... |
| North-Central | Rinderpest | 1636 | 651 | 124 | 1413 | 99 | ... |
| | Foot-and-mouth disease | ... | ... | ... | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| Uva | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 1 | ... | 1 | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Rabies (Dogs) | ... | ... | ... | ... | ... | ... |
| Sabaragamuwa | Rinderpest | ... | ... | .. | ... | ... | ... |
| | Foot-and-mouth disease | ... | ... | ... | ... | ... | ... |
| | Anthrax | .. | ... | ... | ... | ... | ... |
| | Rabies (Dogs) | 1 | ... | ... | ... | ... | 1 |
| | Piroplasmosis | 1 | ... | ... | ... | 1 | ... |
| | Haemerrhagic Septicaemia | 5 | 5 | ... | 5 | ... | ... |

*1 case in a cow.

G. V. S. Office,
Colombo, 10th March, 1931.

G. W. STURGESS,
Government Veterinary Surgeon.

# METEOROLOGICAL REPORT

## FEBRUARY, 1931

| Station | Temperature | | | | Humidity | | Amount of Cloud | Rainfall | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean Maximum | Difference from Average | Mean Minimum | Difference from Average | Day | Night (from Minimum) | | Amount | No. of Rainy Days | Difference from Average |
| | ° | ° | ° | ° | % | % | | Inches | | Inches |
| Colombo - | 88·1 | + 1·1 | 73·9 | + 2·7 | 72 | 90 | 4·6 | 3·48 | 6 | + 1·41 |
| Puttalam - | 90·3 | + 3·5 | 72·1 | + 2·9 | 67 | 90 | 3·9 | 0·27 | 3 | – 1·01 |
| Mannar - | 88·2 | + 2·2 | 75·2 | + 2·3 | 68 | 88 | 3·2 | 0.00 | 0 | – 1·32 |
| Jaffna - | 85·5 | + 0·9 | — | — | 72 | — | 4.1 | 0·01 | 1 | – 1·27 |
| Trincomalee - | 82·6 | 0 | 77.6 | + 2·9 | 76 | 80 | 4·4 | 2·53 | 4 | + 0·35 |
| Batticaloa - | 83·2 | + 0·4 | 75·3 | + 2·7 | 78 | 91 | 6.2 | 3·35 | 8 | – 0·09 |
| Hambantota - | 86·2 | + 0·4 | 73·6 | + 1·5 | 73 | 90 | 3·8 | 1·51 | 5 | + 0·10 |
| Galle - | 87·0 | + 2·7 | 74·1 | + 0·8 | 77 | 90 | 4·8 | 1·39 | 10 | – 1·55 |
| Ratnapura - | 93·1 | + 3·8 | 72·2 | + 0·2 | 64 | 93 | 4·1 | 3·59 | 13 | – 0·98 |
| A'pura - | 87·4 | + 1·2 | 69·3 | + 0·3 | 67 | 87 | 4·7 | 0·00 | 0 | – 1·55 |
| Kurunegala - | 90·5 | + 0·3 | 70·5 | + 1·6 | 63 | 90 | 4·3 | 0·21 | 2 | – 1·52 |
| Kandy - | 86·0 | + 1·5 | 69·1 | + 2·6 | 62 | 85 | 3.4 | 0·85 | 4 | – 1·40 |
| Badulla - | 78·9 | – 0·1 | 64·2 | + 2·1 | 78 | 97 | 5·2 | 4·19 | 6 | + 1·26 |
| Diyatalawa - | 76·0 | + 2·0 | 57·5 | + 1·4 | 70 | 91 | 4·6 | 1·15 | 4 | – 1·17 |
| Hakgala - | 71·3 | + 0·4 | 52·5 | + 2·9 | 78 | 88 | 5·0 | 2·82 | 5 | – 0·49 |
| N'Eliya - | 70·8 | + 1·4 | 45·8 | + 2·0 | 64 | 90 | 4·4 | 1·44 | 6 | – 0·58 |

The rainfall of February was mainly in deficit, a large majority of the rain-gauge stations north of the Puttalam-Trincomalee line reporting no rain at all during the month. Excess, however, predominated in the southern half of the Eastern Province, and on the north-eastern slopes of the hills, while the Colombo district also showed a slight excess.

Falls of over 5 inches in a day were recorded at St. Martin's, (Upper 7·10 inches, Lower 5·40), Hendon, (6·72) and Viragoda (6·15).

Temperatures, both by day and by night, were in general distinctly above normal. A noteworthy example was on the 21st when Colombo's minimum temperature at night only went down to 78°F which is unusually high for this time of year. The humidity was above normal by day, while by night it was, on the whole, about normal. At the coast the amount of cloud was slightly above normal, while inland and among the hills it was slightly below. The duration of bright sunshine was distinctly above average.

The wind was dominantly NE, and above normal strength, though light enough for the effect of sea breeze to be apparent on the west coast. The barometric pressure was also above normal.

A. J. BAMFORD,
**Superintendent, Observatory.**